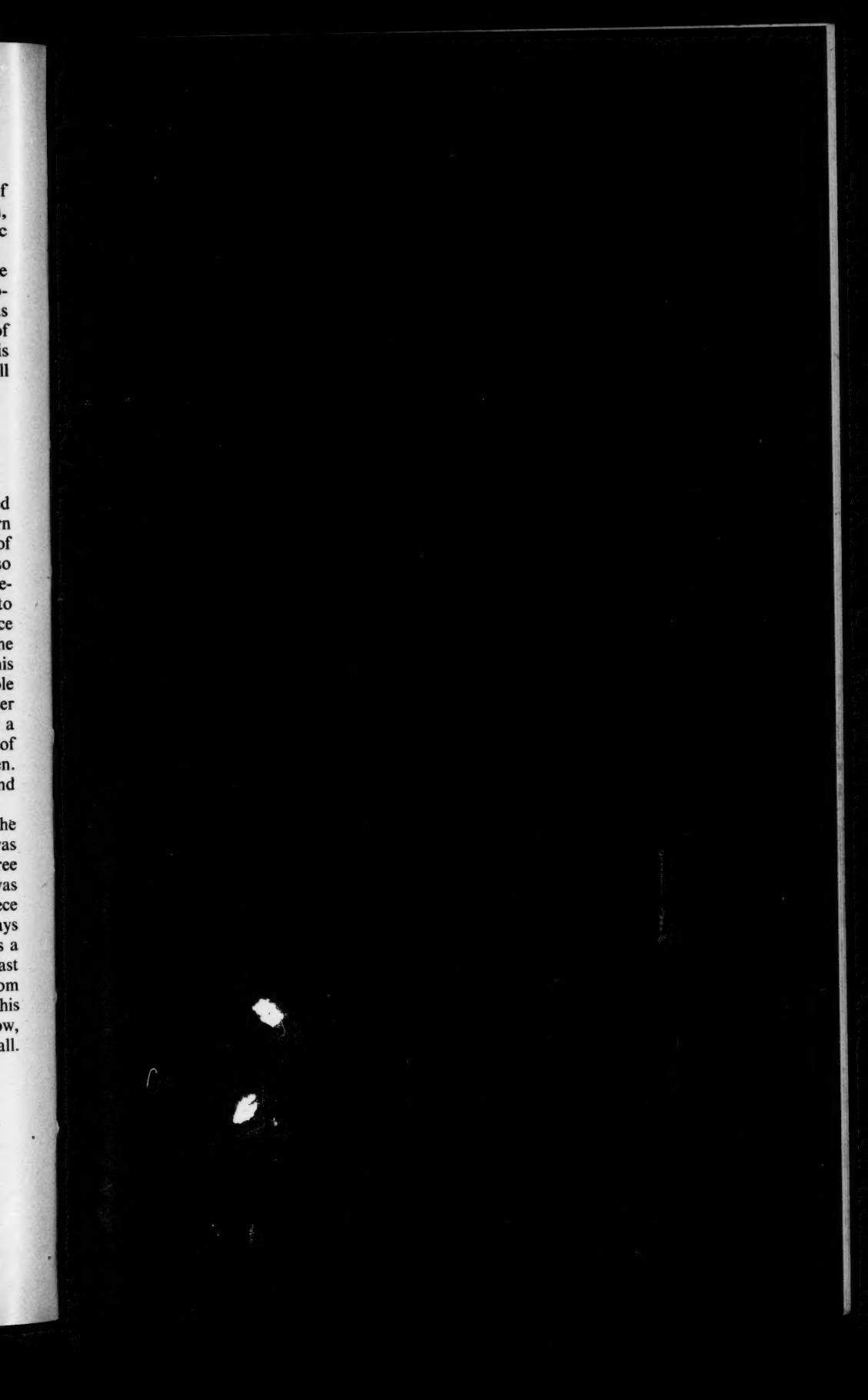

Brit. J. Ophthal. (1952), **36**, 657.

COMMUNICATIONS

PROLIFERATION OF LIMBAL MELANOBLASTS INTO THE CORNEA IN RESPONSE TO A CORNEAL LESION*

AN EXPERIMENTAL STUDY

BY

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WHEN an artificial lesion is made in the cornea of the rabbit, there is besides an intrusion of the new blood vessels from the limbus, a proliferation or "sliding" of conjunctival epithelial cells including pigment cells into the cornea. This has been observed by Mann and Pullinger (1943), Maumenee and Scholz (1948), and Campbell and Michaelson (1949).

The following report indicates that proliferation of the limbal melanoblasts into the cornea is apparently, under certain circumstances, a constant reaction to an experimental lesion of the cornea in the rabbit; that the proliferation has certain features in common with the vascular proliferation and occurs at the same time; and that both proliferations are probably due to the same stimulus. It incidentally indicates possibilities of studying factors which may effect the elaboration of pigment in pigment cells.

Method

A large number of observations were available because they could be obtained from the control eyes (left eyes) in a series of experiments carried out for other purposes. The following preparations were available for observation:

(1) Preparations of rabbit corneae prepared in the following manner: a lesion was placed in the cornea by means of an electro-cautery 2.0–3.0 mm. from the limbus at 12 o'clock. The wound was about 1.2 mm. in diameter and included about two-thirds of the corneal thickness. The lesion was standardized by supplying the cautery with a fixed voltage and applying it for a fixed time. The cauterization was renewed each day for a period of 4–10 days. On the final day the animal was given a lethal dose of prodormol. Immediately thereafter, an injection of India ink under pressure was made into the carotid arteries, thereby demarcating in most cases the new-vessel proliferation into the cornea. The appropriate pieces of the corneae were then cleared, mounted in glycerine, and examined on the flat with a stereoscopic microscope, using a magnification of $\times 17$. After this examination several of the corneal pieces were embedded in paraffin, sectioned, and stained with haemalum and eosin. In this way 100 corneal preparations were made available for observation. They were all from left eyes which had been used as controls, and had received no treatment except subconjunctival injection of a bland substance such as normal saline.

(2) Preparations similar to the above were obtained from corneae which had been treated with *x* radiation during the period of ulcer production or immediately after cauterization had been stopped. In all cases a total of 1,500r, divided into three to six doses, had been given. These eyes represented the paired right eyes of some of the hundred left eyes used as controls.

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FIG. 1.—Normal pigment band around limbus of cornea in the rabbit (× 9).

FIG. 2.—Section of pigment band at limbus. The melanoblasts lie chiefly in the basal layer of the conjunctival epithelium. In this position the pigment appears in the form of a clump, lying like a cap at the side of the cell nucleus directed towards the surface of the epithelium.

Results

In interpreting the results the following points must be noted. Around the limbus in the rabbit there is a well-marked and often dense band of pigment-containing cells (Figs 1 and 2). Most of the pigment is contained in melanoblasts situated in the basal layer of the conjunctival epithelium. In the superficial layers fine dots of pigment are present, whereas in the basal layer the pigment is in the form of a clump, frequently lying like a cap on the side of the cell nucleus directed towards the surface of the epithelium. In man there are similarly situated cells but the pigment content varies according to race (Redslob, 1922).

In the normal rabbit there are

FIG. 3(*a*).—Cornea examined on the flat, showing corneal wound, and associated ill-injected vascular triangle. Co-extensive with this triangle a pigment proliferation has taken place from the limbal pigment band. The poor injection of the vascular triangle enables the pigment triangle to be seen more clearly (× 11).

often local areas where this pigment band narrows and in places there may even be a gap in it. These gaps and areas of narrowing are not confined to any particular region of the band. The normal cornea contains no pigment cells.

100 Untreated Corneae

(1) In eighteen of these corneae (18 per cent.) there was pigment present, easily observable with a magnification of × 17 within the triangular area of the new-vessel formation (Figs 3*a* and *b*). The pigment is always fairly closely confined to this triangular vascular area, with its base at the limbus and its apex directed towards the corneal wound. In the majority of corneae in this group, however, no pigment was discernible in the vascularized

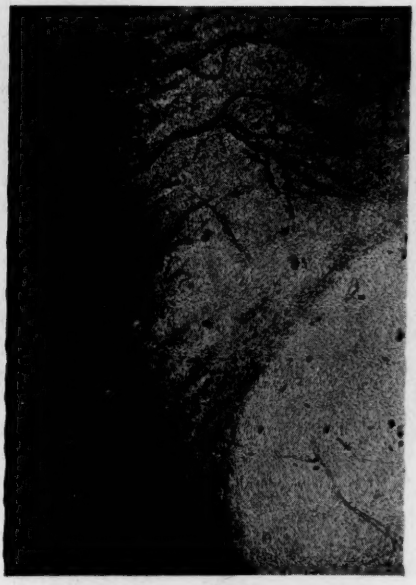

FIG. 3(*b*).—Higher magnification of section of Fig. 3(*a*), showing one basal angle of pigment-vascular triangle (× 25).

area with the magnification used (Fig. 4).

(2) A gap in the limbal pigment ring was noted in 80 per cent. of the preparations, using a magnification of ×17. The gap was opposite the base of the area of vascularization or pigment intrusion (Fig. 5).

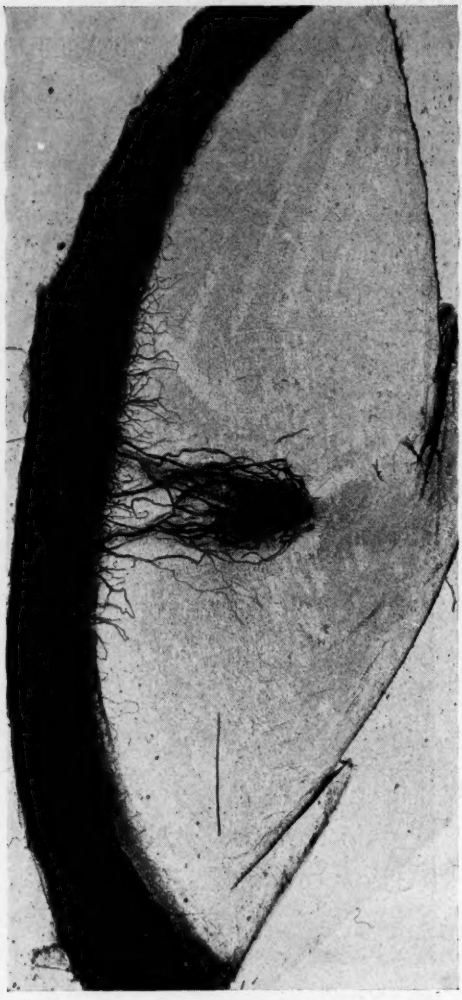

FIG. 4.—Corneal wound with triangular area of new blood vessels (× 9). No pigmentation visible with a magnification of (× 17).

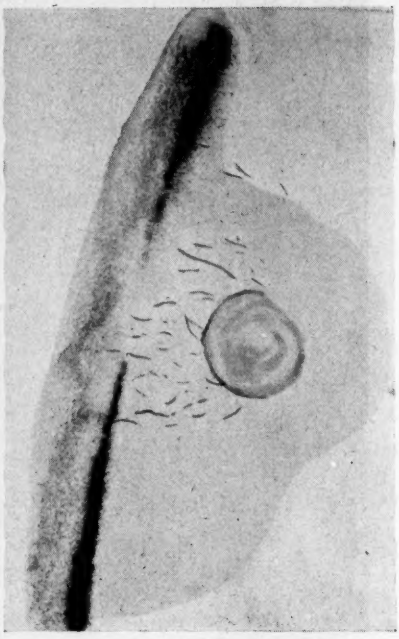

FIG. 5.—Gap in limbal pigment ring opposite site of injury.

(3) Sections of one of the corneae with observable pigmentation show that the pigment is contained in cells situated in the epithelium superficially to the pannus (Fig. 6, opposite). The pigment is seen lying chiefly in the deeper cells of the epithelium situated around the outer pole of the nucleus as already noted above in the limbal epithelium. One or two pigment cells can be seen in the superficial layers of the propria. The superficial epithelial cells contain very fine pigment dots. This appearance was also observed in the sections of several corneae in which no pigmentation was seen with the flat preparations at a magnification of ×17.

FIG. 6.—Section of cornea from area showing pigment and vascular intrusion. The pigment lies chiefly in the deeper epithelial layers. One or two pigment cells can be seen in the superficial layers of the propria. The superficial cells of the epithelium contain fine pigment dots. The linear dark mass lying in the propria is a blood vessel filled with ink.

(4) When the lesion was 4 mm. or more from the limbus, neither pigment cell nor vascular proliferation took place from the limbus.

It may be concluded from these observations that proliferation of the limbal melanoblasts takes place in response to a lesion placed in the cornea within a critical distance from the limbus and that this proliferation takes place over an extent roughly corresponding to the vascular proliferation. This process appears to take place regularly if one can judge from the interruption in the pigment band which occurs in the vast majority of eyes. The melanoblasts which proliferated into the cornea tended to lose their pigment, however, and only in about 18 per cent. of eyes is the pigment content of the proliferated cells such as to be discernible with the magnification used with the flat preparations.

There is evidence that the proliferation of conjunctival limbal epithelial cells is not confined to melanoblast cells (Maumenee and Scholz, 1948). The process has been described as a "sliding" of the limbal cells (Mann and Pullinger, 1943), but, since the intrusion into the cornea in many cases much more extensive than the original narrow pigment band at the limbus, it may be assumed that there is an actual proliferation of the pigment cells in the direction of the corneal wound. As the pigment under the magnification used was discernible in only 18 per cent. of the corneae, it would appear that the melanoblasts tend to lose their pigment in the conditions of rapid proliferation. The results reported from these eyes which received radiation show that such cells may become re-pigmented.

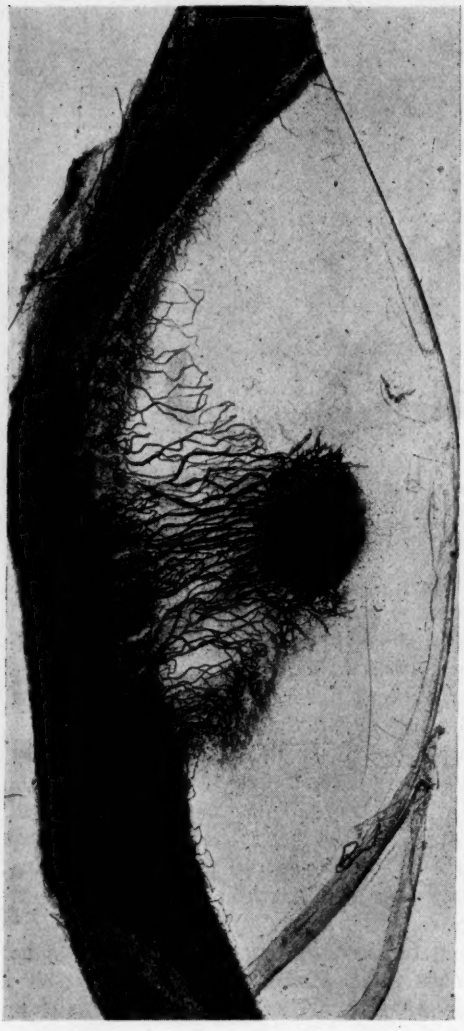

FIG. 7.—Corneal wound with triangular infiltration of blood vessels and pigment (× 9).

29 Corneae treated with *x* Radiation

(1) In 27 of these corneae (92 per cent.), pigmentation was discernible with a magnification of ×17 (Figs 7, 8, and 9). Because of the greater number of eyes with better pigmented corneae in this group, it is possible to draw further conclusions regarding the relationship between the pigment and the vascular triangles. In some cases the base of the pigment triangle appears to be slightly larger than that of the vascular triangle. In some cases the height of the vascular triangle is greater than that of the pigment triangle, while in some it is less. Some of these differences may be merely apparent and due to insufficient pigmentation of the potential melanoblasts by the radiation or to insufficient filling of the new capillaries with ink. It may be concluded that the pigmented and vascular triangles have similar positions and shapes, although sizes may differ. The similarities and differences between the vascular and pigmented triangles is well indicated in Figs 10 and 11 (overleaf); here the vascular triangle happened to be rather unusual, with a shortened base eccentric to a vertical line dropped from the wound to the limbus. The pigmented triangle shows precisely the same eccentricity of formation, but the pigment proliferation has advanced farther into the cornea.

(2) A gap in the limbal pigment ring was noted in 81 per cent. of the preparations, using a magnification of ×17.

The similarity between the number of cases showing a pigment limbal gap in the untreated and radiated groups indicates that the proliferation of pigment cells into the cornea occurred in the radiated eyes with a frequency

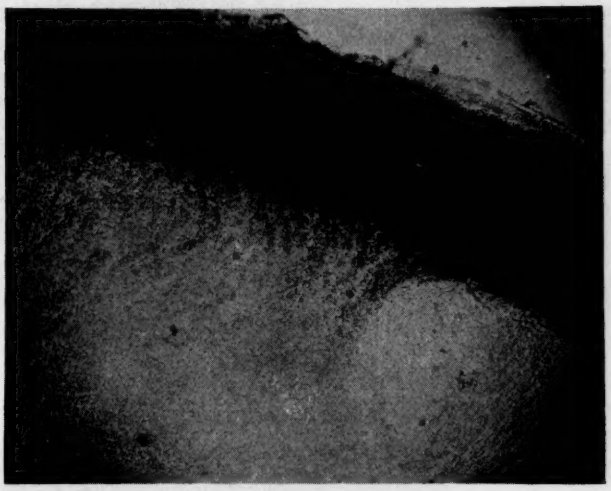

FIG. 8.—Pigment intrusion into the cornea directed towards a corneal wound not seen in the illustration. The breaking up of the pigment band opposite the area of intrusis well seen (× 25).

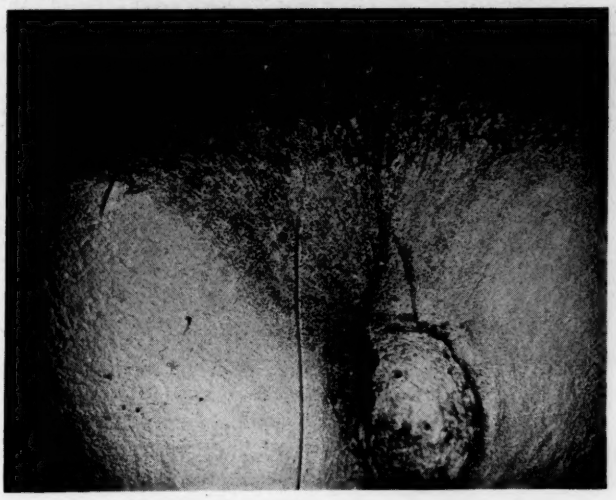

FIG. 9.—Corneal wound with triangular intrusions of pigment and vessels from the limbus. The intrusion of pigment is more extensive than that of the vessels (× 25).

similar to that with which it occurred in the untreated eyes. The disparity between the percentages of cases showing pigment in the cornea in the radiated and untreated eyes (92 per cent. as against 18 per cent.) indicates that pigment cells quickly resume their capacity to form pigment under the influence of the radiation. It is well known that radiation may activate the formation of melanine in potential melanoblasts.

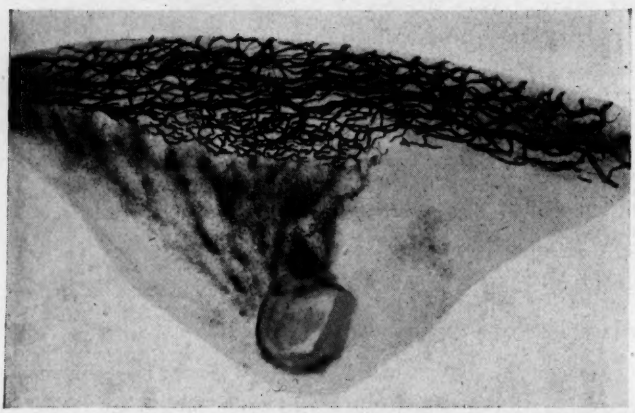

FIG. 10.—Vessel and pigment infiltrations into the cornea are similarly asymmetrical to a vertical line dropped from the wound to the limbus.

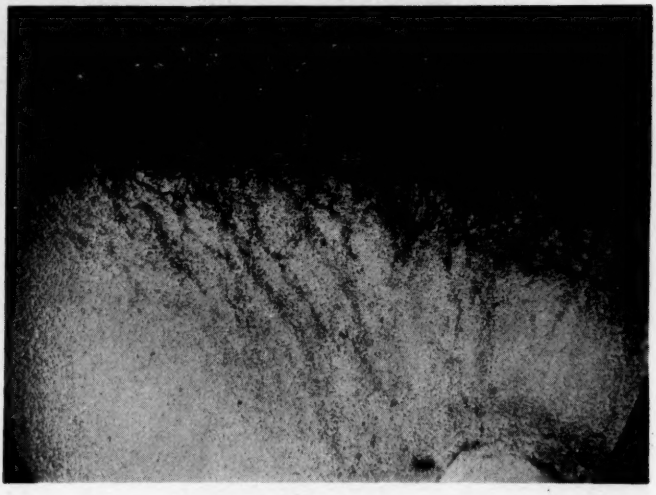

FIG. 11.—Higher power of a section of Fig. 10 (× 25).

Discussion

The similarities in shape and position of the triangular area of pigment cell proliferation into the cornea with that of new vessel proliferation which occurs at the same time, indicates that the mechanisms initiating the two processes are possibly similar. It has been suggested that the new vessel formation is stimulated by a factor formed at the site of the corneal injury which is capable, after diffusing through the cornea, of stimulating the budding of the limbal capillaries (Campbell and Michaelson, 1949). The triangular distribution of the proliferated pigment cells with the apex directed towards the corneal lesion indicates that a similarly operating factor may affect the

pre-existing cells at the limbus. The cells tend to lose their pigment in the process of rapid proliferation, but can be induced to re-elaborate it under the influence of radiation. The possibility of inducing pigment-containing cells to migrate across a sharp boundary into a transparent and therefore easily observed territory normally free from pigment cells, the fact that such cells frequently lose their pigment in the process, and the possibility of stimulating a measurable degree of re-pigmentation open up the possibility of studying factors which may influence the elaboration of pigment in melanoblasts.

Although this communication confines itself to the behaviour of the melanoblasts at the limbus in response to a corneal injury, it is probable that the other epithelial limbal cells behave in a comparable fashion.

Summary

(1) Pigment cell proliferation from the limbus into the cornea was studied in 100 rabbit eyes in which a standard lesion was placed within 2–3 mm. of the limbus. Although in the flat preparations with the magnification used ($\times 17$) pigment was found in only 18 per cent. of these corneae, the presence of a gap in the normal pigment band at the limbus in the great majority of the eyes indicates that pigment cell proliferation into the cornea is a normal response to this type of wound.

(2) The effect of *x* radiation (1,500r in divided doses) upon the pigment cells proliferating into the cornea was studied in 29 rabbit eyes which had received a standard lesion similar to the above. The presence of pigment in almost all the corneae examined supports the idea that pigment cells proliferate regularly in such circumstances, and indicates the ease with which the newly proliferated cells can be induced to re-elaborate their pigment.

(3) Certain similarities in the distribution of the pigment cell proliferation and the new vessel proliferation into the cornea indicate that a similar factor induces both. This factor may be material elaborated at the site of the injury and diffused through the cornea to the limbus.

(4) The measurable proliferation of pigment cells into a territory normally transparent and non-pigmented opens up the possibility of studying factors which may influence the elaboration of pigment in pigment cells.

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REFERENCES

CAMPBELL, F. W., and MICHAELSON, I. C. (1949). *British Journal of Ophthalmology*, **33**, 248.
MANN, I., and PULLINGER, B. D. (1943). *Amer. J. Ophthal.*, **26**, 1253.
MAUMENEE, A. E., and SCHOLZ, R. O. (1948). *Bull. Johns Hopk. Hosp.*, **82**, 121.
REDSLOB, E. (1922). *Ann. Oculist., Paris*, **159**, 523.

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STIMULUS TO CONVERGENCE IN NORMAL AND ASTHENOPIC SUBJECTS*

BY

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A new type of stereoscope has recently been described (Asher and Law, 1952) in which the lateral separation of the cards and their distance from the lenses may both be varied separately, thus exercising accommodation and convergence independently of each other. It was expected that when the images of the cards were at infinity, the normal orthophoric observer would find fusion easiest with the visual axes parallel. However, it was at once apparent that this was not so, since the majority of observers found it easier to combine the pictures with the visual axes converged by as much as 10° or even more, and quite difficult to combine them with the visual axes parallel. Even patients with a pronounced exophoria would set the instrument so as to combine the images in an over-converged position.

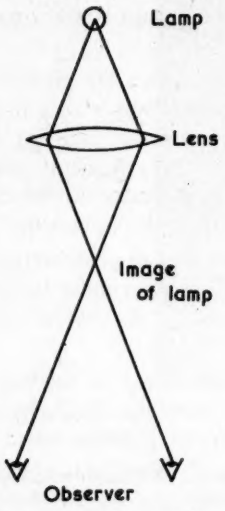

FIG. 1.—Vergence and disparity clues from the real image of the lamp give information that the lamp is on the near side; nevertheless it appears at first to be on the far side. This is because the real image of the lamp does not obstruct the view of anything behind it.

Enquiry showed that this effect is familiar to many who use instruments of this kind. Hofstetter (1942), Morgan (1944), and Ittelson and Ames (1950) have shown that awareness of the position of the object (the proximal factor) can affect both accommodation and convergence. It is the purpose of this paper to demonstrate the extent to which the usual clinical tests, such as the Maddox rod and the Maddox wing, are influenced by the proximal factor; then to study the role played by this factor in determining convergence both in normal and asthenopic subjects; and finally to indicate the bearing of the results upon the diagnosis of asthenopia and upon the amount of correction advisable in presbyopia and hypermetropia.

The importance of the proximal factor may be shown by the following very simple experiment (Fig. 1).

A small lamp is placed at about 20 cm. from a +10D spherical lens, so that a real inverted image of the lamp is formed at a distance of 20 cm. from the lens and on the

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other side of it. The observer places his head about 30 cm. from this image, and by closing each eye in turn makes sure that each does in fact receive light from it. With both eyes open he now sees two lamps, somewhat out of focus and apparently situated on the far side of the lens. If a pin is placed by the real image and fixated, the lamp is immediately seen as single and clearly focused. After a while a pleasantly vivid sense of the position of the image in space develops, and this may even cause the observer to cry out with pleasure. The impression can now be maintained when the pin is removed.

It is clear that the eyes converge and accommodate to the point on the far side of the lens where the light is thought to be. It is thought to be there because the image does not obstruct the vision of any part of the view on the near side, as would a real object in this position. Both the vergence of the light rays and the disparity between the retinal images give information that the image is on the near side, so that with a little practice the image may be seen in its true position. What is of interest is that, for the unpractised observer, the 'common-sense estimate' of the position of the lamp, based chiefly on absence of obstruction, will outweigh the other clues.

The following investigation was carried out to find more precisely the role played by the 'commonsense estimate' in determining convergence and accommodation, both in normal observers and in those with convergence defects.

Material

Tests were made with 22 normal observers; for the purposes of the tests a person was classed as normal if he had no symptoms of eye strain, irrespective of whether he had a latent squint or not. All were volunteers from the Birmingham Medical School, and they were mostly medical students in their early twenties, though a few older people were also included. Thirteen patients having symptoms thought to be associated with convergence defects were also tested; of these, eleven were attending for treatment at the Orthoptic Department of the Birmingham and Midland Eye Hospital, and two were found among the volunteers from the Medical School. They included cases of esophoria, exophoria, and convergence insufficiency.

Tests

Test 1. (See keys to Figs 2 and 3)

Any refractive error is corrected by lenses placed in a trial frame and correctly centred. The normal set-up for a Maddox rod test is used. The rod is placed in front of the left eye and the usual scale with the light in the centre is placed on the wall at 6 m. from the observer. Concave lenses of −1D, −2D, −3D, etc., are now placed in succession in front of both eyes. Consider as an example the case when a pair of −2D lenses is placed in the frame. The wall may be taken as virtually at infinity, so that with the −2D lenses an accommodative effort of +2D is required to focus the image of the scale on the retina. This is the effort normally required for an object at 100/2 = 50 cm. distant; in other words the concave lenses make the light rays diverge as if they originated from a scale placed 50 cm. away from the observer, and we may say that there is an image of the scale formed in space in this position. Alternatively, using the formula $1/v + 1/u = 1/f$ and substituting $u = \infty, f = -50$ cm. (for the −2D lens), we get:

$$1/v = -1/50, \text{ or } v = -50 \text{ cm.},$$

showing that there is an image of the scale 50 cm. in front of the observer.

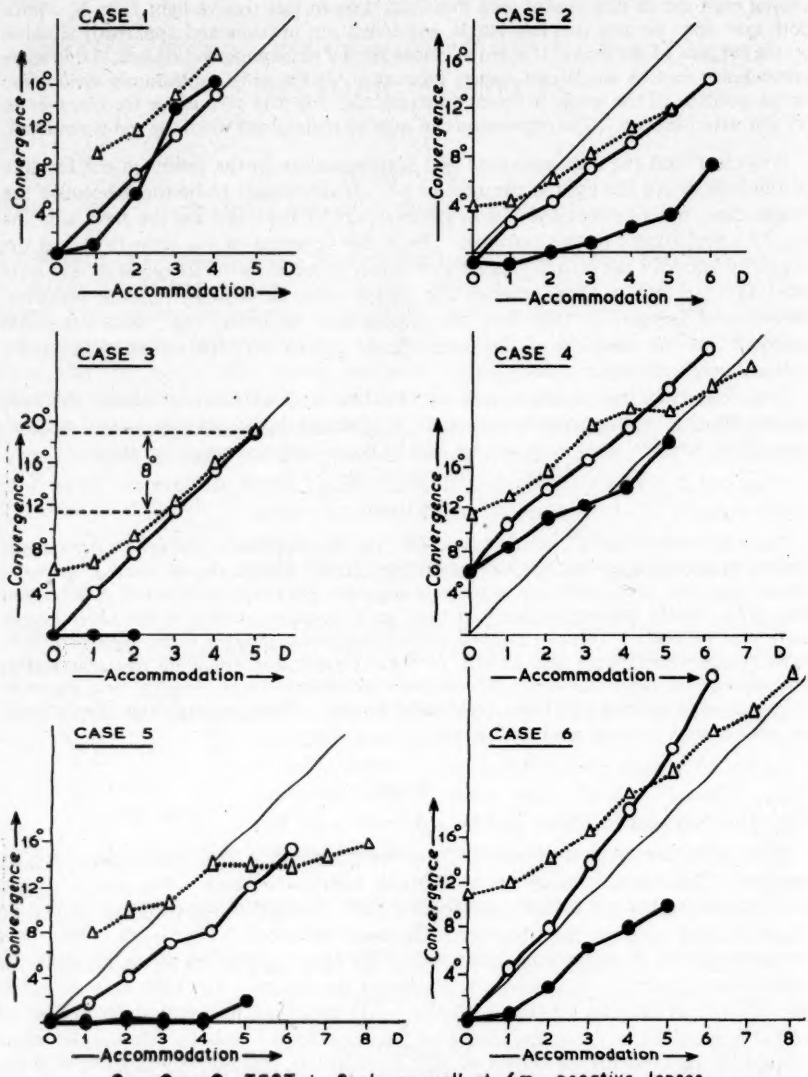

FIG. 2.—Results of Tests 1, 2, and 3 in six subjects with no symptoms.

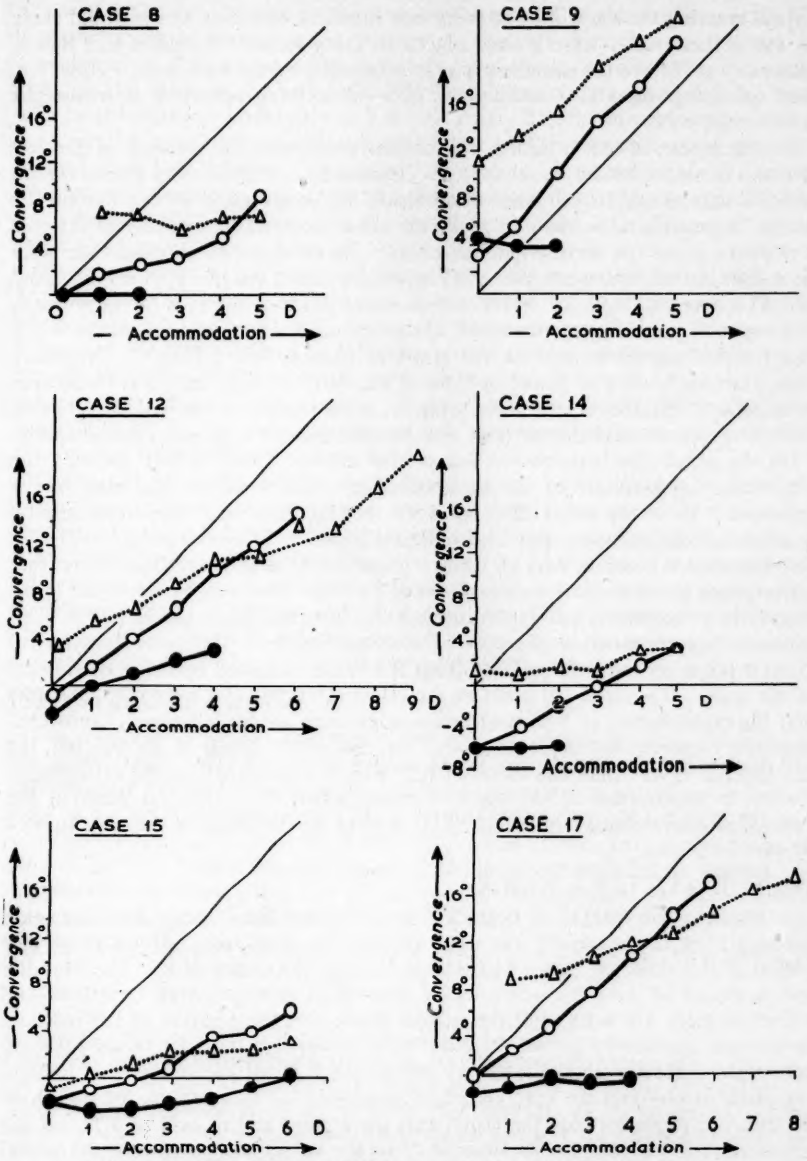

FIG. 3.—Results of Tests 1, 2, and 3 in six asthenopic patients.
Case 8—Convergence insufficiency Case 9—Esophoria
Case 12—Exophoria Case 14—Exophoria
Case 15—Exophoria Case 17—Convergence insufficiency

Rays entering the eye will be in every way identical with rays which would enter the eye if there really were a scale placed in this position, of such a size that it subtended at the eye the same angle as is subtended by the wall scale. However, since this image does not obstruct the view of anything behind it, it is thought to be on the wall.

For each pair of lenses added, the patient announces the position of the red line, and in each case the visual acuity is checked by a Snellen chart placed on the wall. Readings are discontinued when vision has deteriorated by one line on the chart. A graph is now drawn in which the actual angle of convergence of the eyes is plotted against the accommodative effort. As an example, suppose that, with the rod in the left eye, when the −2D lenses are added the line appears displaced by 2.5° to the left, then 2.5° is the actual convergence of the eyes (if, as is usual, we count 6 m. as an infinite distance); the accommodative effort is of course +2D. This point is the third point on the graph of Case 6, Test 1 (Fig. 2). In many cases a concave lens was placed in front of the right eye only, as it was found that an intelligent observer could easily bring the scale sharply in focus while ignoring the lack of sharpness in the red line; this enabled the test to proceed more rapidly.

On the graph the orthophoric line is also drawn; this is a line showing the convergence appropriate to the accommodation, calculated on the basis of the measured P.D. of the patient, for an object moving in towards him from infinity. A graph which lies below this line indicates a deficit of convergence relative to accommodation (Case 6, Test 1), while a graph which is above the line shows that convergence is relatively in excess (Case 6, Test 2). It is well to avoid the terms exophoria or esophoria in connection with this test, because it would not be clear whether they indicated departures of convergence from the value required to fixate a point on the wall scale or from the values required to fixate the images of this scale. Thus, the 3rd point on the graph for Test 1 of Case 6 (Fig. 2) shows that the convergence of 2.5° is excessive in relation to the (effectively) zero convergence required for the wall scale; on the other hand, it shows that the convergence is less than the value of 6.5° which is indicated by the orthophoric line to be appropriate to the accommodative effort of −2D, and which is the amount of convergence required to fixate a point on the image of the scale formed by the +2D lens.

Test 2. (See key to Figs 2 and 3)

A smaller scale marked in degrees is so made that the 1° scale divisions again subtend 1° at the observer's eye when placed 1 m. from him. The scale then is placed at this distance, and a light shines through the centre of it. The Maddox rod is placed in the left eye, no lenses other than those required to correct any refractive error are worn, and the subject announces the position of the red line. If the line appears to go through the lamp it signifies that the visual axes are converged correctly upon the lamp, and as the P.D. of the observer is known, the angle of convergence may be simply calculated. For example, for a P.D. of 65 mm., the angle between the visual axes for a point at 1 m. will be 3.7°. If the observer now sees the line as situated 2° to the left of the lamp, then his actual convergence will be 3.7 +2 = 5.7°. Now the accommodative effort involved is 1 dioptre, and this is exactly the same as for the case when the observer wore a −1D lens and looked at the scale on the wall. This can also be expressed by saying that the card is placed so as to occupy the position in which the image of

the wall scale was situated in the corresponding part of the previous test. The amount of convergence is quite different in the two cases, because in each test the observer is fully aware of the real position of the scale. When he thinks he is looking at a scale on the wall the convergence is much less than when he knows that he is looking at a real card at 1 m. distance. The difference between the two amounts of convergence indicates the extent of the psychological effect. A second card, half the size of that used at 1 m., is now placed at 50 cm., and the observation is repeated. Suppose this time that the line appears to be displaced 3° to the left; the convergence for the line at zero will be $2 \times 3.7° = 7.4°$, so that the actual convergence will be $7.4° + 3 = 10.4°$.

The experiment is now repeated using cards of appropriate size placed at 33, 25, and 20 cm. distance, so that a card test is carried out to correspond with each of the -1, -2, -3, -4, and -5 dioptre lenses used in Test 1. Visual acuity is checked for each position by a Snellen chart, reduced photographically by the correct amount, and placed by the card. It was found helpful to move the card sideways until the red line appeared to pass through it, for by this means it was possible to be certain that the observer was accommodating correctly while he was reading the position of the red line.

The results are shown graphically in Figs 2 and 3. Here there is no ambiguity in the terms esophoria and exophoria, and a point which lies above the orthophoric line represents an esophoria, while a point below it indicates an exophoric condition. It is useful here to notice that the values for the phorias obtained in this way with the card at 30 cm., are approximately double those which are found using the Maddox wing. The reasons for this important difference are not understood. The value of the phoria at any distance may be read from the graph by noting the distance of the point above or below the orthophoric line.

Test 3. (See key to Figs 2 and 3)

The card used at 20 cm. distance in the previous test is the only one used in this experiment; it is placed at 20 cm. from the observer together with the appropriately reduced Snellen chart. The Maddox rod is placed as before in front of the left eye. A lens of $+5D$ is now added in front of the right eye and the observer is asked to read the chart. The image of the chart is at infinity, so if he reads it to Line 6 we can assume that the accommodation is relaxed. If the observer now states that the line is, say, 10° to the right, we can calculate the actual convergence as follows:

If the visual axes were converged upon the lamp, the angle between them would be

$$2 \times \tan^{-1}\left(\frac{6.5}{2} \times \frac{1}{20}\right) = 2 \times 9° = 18°.$$

The fact that the line is 10° to the right indicates that he has converged by 10° less than is required by the real position of the card; thus his actual convergence is $18° - 10 = 8°$. The image of the card is at infinity, so that this represents an excess of convergence relative to accommodation. If the observer is orthophoric as shown by the normal Maddox rod test at 6 m., we may deduce that the awareness of the nearness of the cards has induced a convergence of 8°.

After this lenses of $+4$, $+3$, $+2$, $+1$, zero, -1, -2, etc., dioptres are added until vision has deteriorated by one line on the chart. With, say, the $+4D$ lens, the subject must accommodate by $+1D$ to make the 5D required for the card at 20 cm.; this is the accommodation normally required for an object at 1 m., so that we may say that there is

an image of the scale at 1 m. For the other positive lenses images will be formed at 50, 33, and 25 cm., while for zero lens the patient sees the real card at 20 cm. Thus the card images coincide with the card positions for Test 2 and the difference between the amounts of convergence represent the influence of the proximal factor. That this influence is considerable is seen by the wide separation of the graphs of Tests 2 and 3 in Figs 2 and 3.

Results

Tests 1 and 2 for Normal Observers (Fig. 2).—As was expected, in most cases the amount of convergence was considerably greater when accommodation was induced by real cards being brought near (Test 2) than when it was caused by the addition of concave lenses. The surprising amount of variation between different observers resulted in their classification into three types:

(1) *Accommodative.*—The relation between accommodation and convergence is approximately the same whether the observer is looking at a virtual image or at a real card. An example is shown in Case 1 (Fig. 2). Only two individuals of this type were found, and strangely both were ophthalmic surgeons. This type is called "accommodative" because convergence appears to be induced solely by the accommodative effort, but a voluntary effort of convergence may also exist.

(2) *Intermediate.*—Some convergence is induced by the concave lenses in Test 1, but there is a markedly greater amount in Test 2 using the real cards. Cases 2, 4, and 6 are examples of this category which was the most numerous.

(3) *Perceptual.*—No convergence at all is induced by the concave lenses, whereas the eyes converge considerably when real cards are brought near (*e.g.*, Case 3). Here it seems that convergence is entirely determined by the perception of the remoteness of the wall.

Test 3 for Normal Observers (Fig. 2).—With the positive lenses and the card at 20 cm., the amount of convergence is in all cases greater than in the corresponding portion of Test 2, the increased convergence being no doubt induced by the awareness of the near position of the real card. Cases 3 and 5 show clearly how variable is the amount of the effect; thus in Case 3 the dotted line is nearly superimposed upon that for Test 2 for the greater part of its length, showing that for this observer the convergence is determined largely by the vergence of the light rays and the psychological effect is very small. By contrast, in Case 5, the dotted line departs widely from that of the full circles and for part of its course runs nearly parallel to the base line, showing that in these regions the estimate of the position of the object preponderates over the vergence clues. Just as in Test 1, some observers are influenced more by the perceived position of the object than by the accommodative effect, and tend towards the perceptual type, while in others the reverse is the case and so that they tend towards the accommodative type. It may be noticed that, as in Case 3, an individual may be a definite perceptual type for Test 1 (negative lenses), and yet tend to the accommodative type in Test 3 (positive lenses).

Tests 1 and 2 for Eye-Strain Group (Fig. 3).—A glance at the graphs of Cases 8, 9, 12, 14, 15, 17 reveals the important fact that perceptual types are very much more common in this group than in the normal group.

The number of normal and asthenopic observers falling into each category is shown below:

Observers	Normal	Eye-Strain
Accommodative	2	0
Perceptual	5 } 22	11 } 12
Intermediate	15	1

Test 3 for Eye-Strain Group (Fig. 3).—There was perhaps a tendency in this group for the proximal factor to predominate over the vergence clues to a greater extent than in the group of normals. There was however little correlation between Test 1 and Test 3, and Test 3 does not distinguish so clearly between normal and asthenopic groups as Test 1.

Discussion

In discussing the problem of latent squint it is usually assumed that, when the stimulus to fusion is removed, the eyes will converge to an extent determined by the accommodative effort involved. The results given here show that this assumption is not true, and that the observer's estimate of the range of the object plays an all-important part. Furthermore, the mechanism of the near reflex varies astonishingly between different individuals. A complete range exists between the accommodative type, who converges as much in Test 1 (with concave lenses) as in Test 2 (with cards), and the perceptual type, who does not converge at all in Test 1. It is remarkable that the complete range of psychological effect from 0–100 per cent. should be found in this very small sample of 22 normal people.

In a complaint described by the term " eye-strain ", one would hardly expect a characteristic result from measurements of this kind, mainly because the symptoms are so often considered to be of mental origin. Consequently it is surprising to find how consistent are the graphed results of the affected group. All the members of this group except one (Case 12) belong to the perceptual type, and in Case 12 there was good reason to expect causes of eye-strain other than convergence defects, because this patient's eyes were constantly in motion, so much so that it was difficult to measure the inter-pupillary distance.

Case 9 was particularly interesting in showing that even in esophoria there may be a failure to increase the convergence when concave lenses are added. The patient was a vigorous male intellectual aged 40, with no psychological symptoms, who complained that " eye-strain " made it hard for him to do the necessary amount of reading. This case should be compared with Case 4, a vigorous female intellectual aged 36, in whom the esophoria (Test 2) is similar, but in whom there were no symptoms. Note the striking difference in the result of Test 1.

Case 17 is interesting because the esophoria at 30 cm. of 5° and 2°

(corresponding to approximately 5△ and 2△ on the Maddox wing) comes within normal limits. This was a case of convergence insufficiency.

By comparing the graphs of the normal observers with those of persons complaining of eye-strain, it appears that there are three factors which may contribute to the cause of this complaint: latent squint, absence of accommodative convergence (perceptual type), and low relative accommodation (short line in Test 2).

Test 3 shows little difference between eye-strain patients and normal observers, but the results are interesting. In all cases the awareness of the proximity of the object viewed caused a convergence which was excessive in relation to the accommodation demanded by the vergence of the light rays, and in many cases there was also a failure to relax the accommodation, an observation originally made by Landolt? This effect is most striking, and it was amusing to see an experienced ophthalmic surgeon (Case 1) who had 6/6 vision at 6 m. without glasses, struggling to read the type on a card at 20 cm. distance from him when given a +5D lens. At first he complained that in view of his age he should not be asked to read type at such a short distance, but on being informed that the image was at infinity he was still unable to relax his accommodation and attained only 6/24 vision. Thus, in Case 1, since zero accommodation could not be obtained, this point is not plotted for Test 3.

The results of Test 3 are very relevant to the prescription of reading spectacles. For instance, in Case 3, positive lenses affect convergence to a considerable extent, and to prescribe them for near work would certainly induce a latent squint. Since the observer is a pronounced perceptual type this would be likely to cause trouble. It is therefore very important to interpret the diagrams correctly, as is shown by the following example:

Suppose in Case 3 we consider the point on the graph defined by 3D accommodation and 11° convergence. Near this point are found a triangle from the graph of Test 3 and a circle from the graph of Test 2, both lying on the orthophoric line and nearly coinciding. In spite of this coincidence the points indicate totally different results in the two tests. A circle plotted at this point in Test 2 shows that there is no phoria when the Maddox rod test is performed with the light and scale at 33 cm., but the triangle plotted above the abscissa value of 3D in Test 3 indicates that, of the 5D of accommodation required for an object at 20 cm., 3D are contributed by the accommodative effort of the observer, so that this point corresponds to the use of a +2D lens in the test. The fact that the triangle lies almost on the orthophoric line shows that the convergence is appropriate to the 3D of accommodation; but this is by no means appropriate to the distance of 20 cm. at which the card is placed, a distance which demands a convergence of 19° from this observer with a interpupillary distance of 65 mm., so that the line appears displaced by 19 − 11 = 8°; in fact, the observer announces this 8°, and by reversal of the above argument the point on the graph is plotted from it.

The work entailed in performing the three tests may take as long as 45 minutes even with an intelligent patient, and is not likely to be applicable clinically in its present form, but it seems likely that useful data could be obtained by making a much smaller number of readings. To simplify

Test 1, a Maddox rod test could be made at 6 m.; a pair of −2D lenses is then inserted, and failure to converge will diagnose the perceptual type in nearly all cases. Test 3 could be simplified by carrying out a Maddox rod or prism diplopia test at 30 cm., and then noting the effect upon convergence of placing, say, a +2D spherical lens in front of each eye.

In discussing the correction of presbyopia, Duke-Elder (1943) states that if too much of the available accommodation is replaced by over-strong glasses the relation between accommodation and convergence is upset, and that this is probably the most usual cause of the asthenopia and discomfort which may follow the correction of the complaint. It seems that the decrease of convergence occurring in the suggested simplified version of Test 3 would be a guide to the amount of correction that can be tolerated, and that when the decrease is considerable incorporation of base-in prisms should be considered.

Summary

It is usually assumed that when the fusion stimulus has been removed the amount of accommodative effort entirely determines the degree of convergence. It is here shown that this is not so, and that for most observers the conscious estimate of the position of an object (the proximal factor) plays a part at least as important as accommodation in determining convergence. The influence of this factor varies greatly from one individual to another.

Tests are described for measuring the effect at long and short distances. At long range, for nearly all asthenopic patients, the estimate of range predominates and prevents convergence, despite the accommodative effort induced by concave lenses; this is a result which could be applied to diagnosis. At short distances, the proximal factor affects the amount of latent squint induced by the wearing of positive lenses, and its measurement intimately concerns the appropriate correction for presbyopia and hypermetropia.

My sincere thanks are due to Mr. L. P. Jameson Evans for letting me examine his patients, to Mr. Frank Law for his help and advice, and to Miss Levinge of the Orthoptic Department of the Birmingham and Midland Eye Hospital for her willing co-operation.

REFERENCES

ASHER, H., and LAW, F. W. (1952). *British Journal of Ophthalmology*, **36**, 225.
DUKE-ELDER, S. (1943). "The Practice of Refraction", 4th ed., p. 139. Churchill, London.
HOFSTETTER, H. W. (1942). *Amer. J. Optom.*, **19**, 67.
ITTELSON, W. H., and AMES, A. (1950). *J. Psychol.*, **30**, 43.
MORGAN, M. W. (1944). *Amer. J. Optom.*, **21**, 183.

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EFFECT OF ACCOMMODATION ON THE RETINAL IMAGE*

BY

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IN text-books on physiological and visual optics we find two diametrically opposed statements.

(1) Some texts say, to quote one as an illustration:

> The size of the retinal image varies directly as the distance of the second nodal point from the retina. Since the optical effect of accommodation is to increase this distance it is accompanied by *an increase in the size of the retinal image.*

(2) Other texts say, again to quote one as an illustration:

> In accommodation the dioptric power (of the eye) is increased . . . The retinal image, therefore, is decreased in size during accommodation.

The latter text also adds that, in Gullstrand's eye,

> the posterior nodal point comes forward from 7·332 to 6·847 mm. (during accommodation). Because of this some writers state that the retinal image increases in size during accommodation. They fail to take into account that while the posterior nodal point advances 0·485 mm. the posterior principal focal point advances 3·855 mm.

These two statements, to which we shall refer as Statement 1 and Statement 2, while seemingly contradictory, are each partly true, though neither is complete. The first says that accommodation increases the size of the retinal image, that is it makes the image "larger", but larger than what? The second says that in accommodation the retinal image is decreased in size, that is the image becomes "smaller", but smaller than what?

Let us first note that there are several kinds of images in the eye. The two we will consider here are:

(*i*) the optical image
(*ii*) the retinal image.

The optical image is the clear focused image formed by the optical system of the eye. In emmetropia, for a distant object, this image falls on the retina and becomes also the retinal image. In myopia it falls in front of the retina. In hyperopia it falls (or tends to fall) behind the retina.

The retinal image is that which falls on the retina. It may be clear or blurred. Its size when blurred may be taken from the point in the diffusion circle where the ray along a secondary axis (through the nodal point) strikes the retina. There are other methods of calculating the size of the blurred retinal image, but they are not pertinent to our present discussion. We will ignore for the present the enlargement due to the diffusion circles.

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Two optical facts agreed on by all are:

(*i*) The object and its *retinal image*, clear or blurred (as defined above), make equal angles at the nodal points: object at N_1, image at N_2. We may consider the two nodal points to be coincident and refer simply to *the nodal point*.

(*ii*) The stronger the optical system, simple or compound, the smaller the real *optical image* formed by that system.

Now, Statement 1 holds good for the retinal image; this is made larger by accommodation, but larger than what? Take an emmetropic eye viewing a distant object and call the size of the (clear) retinal image x. If the eye viewing the *same* distant object accommodates, say, 3.00 D., the retinal image of the object is now blurred and larger than x, since during accommodation the nodal point has moved forward. We may call this image y. Then $y > x$.

Suppose the normal emmetropic eye accommodates for an object 35 cm. away. It gets a clear *retinal image* of the object which we may call u. If the eye now relaxes all accommodation while viewing the same object at the same distance, a blurred retinal image is formed, which we may call v, and since in u the nodal point is further from the retina, $u > v$. Here too the retinal image during accommodation is larger than the retinal image during non-accommodation. All this conforms with Statement 1. But this comparison of a clear retinal image with a blurred retinal image of the same object at the same distance (blur and change in size being due to changes in accommodation) is not a very satisfactory comparison.

Turning to Statement 2, we may suppose that the normal emmetropic eye views a distant object. The *optical image* formed by the eye, which we may call m, is on the retina. We have here a clear retinal image. Suppose the eye while viewing the same distant object accommodates, say, 3.00 D. The refractive power of the eye has now increased by 3.00 D. and the *optical image*, which we may call n is now formed in *front* of the retina, and is smaller than the optical image m formed by the weaker refractive system (*i.e.*, the non-accommodated eye). Thus $n < m$.

In this sense the size of the *optical image* of an object at distance during accommodation is smaller than the size of the optical image of the same object in non-accommodation. But we do not see with the optical image, but by the stimulus resulting from the *retinal image*. During accommodation for a distant object the blurred retinal image, call it y, is larger than x as was shown previously.

Similarly, suppose the eye views and accommodates for an object at, say, 35 cm. The optical image now falls on the retina, and its size may be called p. If the eye now relaxes its accommodation while still viewing the object at 35 cm., the *optical* image of the object, which we may call q, is larger than p (weaker refractive system). It is located behind the retina. But as the accommodation is relaxed and the nodal point moves backward the retinal image (blurred) is smaller than the retinal image when the eye accommodated.

Thus Statement 2 is correct when referring to the optical image and is more complete when comparisons are made as outlined above.

However, the most logical way of noting the effect of accommodation on the size of the retinal image (the image by which we see) is to compare the *clear* retinal images which are obtained under the two sets of conditions. Thus, if a distant object subtends a 2° angle at the nodal point of the static eye, the retinal image is clear and its size may be determined by the radian method as $\frac{I_D}{16{\cdot}5} = \frac{2}{57{\cdot}3}$. In this equation, I_D is the clear image of the distant object, 16·5 the distance in mm. from the retina to the nodal point in the simplified schematic eye, and 57·3 the value of the radian angle; thus $I_D = 0{\cdot}5759$ mm.

Now suppose an object subtending the same angle of 2° at the nodal point of the accommodated eye is placed close to the eye and the eye accommodates for it. If the distance from the retina to the present position of the nodal point has increased to 16.8 mm., then $\frac{I_N}{16{\cdot}8} = \frac{2}{57{\cdot}3}$.

In this equation, I_N is the clear retinal image of the near object subtending the same visual angle; thus $I_N = 0{\cdot}5864$ mm.

Thus the clear retinal image of a near object which subtends a given angle *a* and for which the eye accommodates, is larger than the clear retinal image of a distant object subtending the same angle and seen without accommodation. This seems the most logical comparison and shows that accommodation increases the size of the retinal image. The proofs of the relative values given in this article can be found in any good text-book on physiological optics (*e.g.*, Duke-Elder, 1940; Cowan, 1938).

Summary

The effect of accommodation on the size of the retinal image is given by some authors as an increase in size during accommodation and by others as a decrease in size during accommodation. One reason for this apparent contradiction is that the first group of authors refers to the *retinal image*, and the second group to the *optical image*; but both statements are incomplete in that there is no reference to the images compared. Several such comparisons are here discussed as well as the special significance of the retinal image. The most logical comparison is that made between the clear retinal image of a distant object subtending a given angle, and the clear retinal image of a near object subtending the same angle, for which the eye accommodates. In this way it may be shown that the retinal image during accommodation is larger than the retinal image during non-accommodation.

REFERENCES

COWAN, A. (1938). "Refraction of the Eye", 1st ed. Kimpton, London.
DUKE-ELDER, S. (1940). "Text-book of Ophthalmology", vol. I. Kimpton, London.

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CHLORAMPHENICOL APPLIED IN CALCIUM ALGINATE CAPS FOR THE CONTROL OF EXPERIMENTAL CORNEAL INFECTION WITH PS. *PYOCYANEA**

BY

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THE ophthalmic usefulness of an antibiotic is judged by the following criteria (Leopold, 1951):

(*i*) ease of penetration into the ocular tissues,
(*ii*) toxicity for ocular tissues,
(*iii*) effectiveness against standard experimental ocular infections,
(*iv*) effectiveness against clinical ocular infections.

The penetration of chloramphenicol was investigated by Leopold, Nichols, and Vogel (1950), who found that by using it as eyedrops in aqueous solution or in propylene glycol, or as an eye ointment, or as subconjunctival injections, the amount penetrating into the aqueous was between 5–22 micrograms. Langham (1951) made the important observation that chloramphenicol given systemically penetrates the blood-aqueous barrier with ease because it is fat-soluble and passes directly through the cells, and that the concentration in the aqueous may approach unity. Streptomycin on the other hand, being fat-insoluble, penetrates the permeable membranes with difficulty owing to the large size of its molecules, and the passage from the plasma into the aqueous is very poor. That chloramphenicol travels about twenty times faster through the blood-aqueous barrier than penicillin, is borne out by clinical experience that the use of systemic chloramphenicol in intra-ocular infections is very effective.

The toxicity was investigated by Azzolini and Faldi (1950), who found that a 0.25 per cent. solution was well tolerated in the rabbit's eye when given subconjunctivally, and that 0.3 ml. of a 0.25 per cent. solution was well tolerated in the anterior chamber. Injected into the vitreous, however, it brought about disorganization of the stroma.

Chloramphenicol is usually applied locally in eyedrops, but the poor solubility (0.25 per cent. in water, 0.5 per cent. in borate buffer solution) is to be noted. It is also given in ointment form and has been tried by different authorities in a variety of conditions, often with contradictory results. It is effective against many organisms not sensitive to penicillin or sulphonamides.

* Received for publication July 21, 1952.

Present Investigations

The use of locally applied chloramphenicol as a prophylactic against experimental corneal infection with *Ps. pyocyanea* has been investigated. Since the concentration of the drug is low when applied by eyedrops or ointments (Leopold and others, 1950), and subconjunctival injections are not well tolerated (Sorsby, 1951), we have tried the effect of applying chloramphenicol powder by means of a flexible calcium alginate cap.

Preparation of Alginate Caps.—A metal mould* was dipped into a 2 to 4 per cent. solution of sodium alginate, so that the viscous fluid covered the corneal and scleral parts over an area the size of a contact lens. This was then dipped into a fluid made up of a concentrated solution of calcium chloride 0.1 ml., distilled water 25 ml., and 10 per cent. acetic acid 0.5 ml. After a few minutes under the influence of calcium ions, a transparent flexible cap was formed which retained its shape on being carefully removed from the mould. These calcium alginate were kept in a weak solution of calcium gluconate until required. Immediately before use the cap was trimmed to the approximate size of a rabbit's eye. After application to the eye, the cap was held in place by suturing the lids by means of a single suture in the middle.

Procedure.—Corneal ulcers were produced by intracorneal injection of a freshly subcultured 24-hr-old human pathogenic strain of *Ps. pyocyanea*. A tuberculin syringe and intradermal needle were used, and with the needle in the right layer a small wheal of 3–4 mm. diameter was produced on the cornea. If left untreated the corneal ulcer took a destructive course, ending in extensive corneal scarring or shrinkage of the globe.

Results.—The Table shows that of six treated rabbit eyes, three were clear after 24 hrs; and that the infection was light in two and moderately heavy in the last. One of the clear eyes subsequently became infected, but the other two remained clear. In the eyes which showed slight or moderate infection, progressive deterioration occurred. Thus a single dose of chloramphenicol was an effective prophylactic in two out of six eyes; in a further two eyes the infection was suppressed to some extent, but subsequently became worse; and in two eyes the drug afforded no protection at all.

These results were obtained by a single application of 60 mg. chloramphenicol powder. No subsequent treatment was given as the aim was to assess the protective effect of a single dose. However, it is reasonable to assume that in two more cases the infection would have been halted by repeated treatment.

When the lid sutures were removed on the second day the alginate caps were found *in situ*. Bacteriological examination of the cap from an eye in which the infection was controlled gave a negative result regarding *Ps. pyocyanea*; in caps from eyes in which infection was not controlled *Ps. pyocyanea* was present.

Subconjunctival Injection.—In two further experiments (Nos 7 and 8), the subconjunctival injection of 30 mg. chloramphenicol suspended in sodium alginate solution gave no protection at all, and marked irritation occurred.

* Supplied by Messrs. G. Nissel and Co.

TABLE

Eye No.	Infection	Treatment	Result after 24 hrs	Remarks
1	Intracorneal *Ps. pyocyanea*	60 mg. chloramphenicol in alginate cap	Clear	Remained clear
2	,,		Infection	Progressively worse after second day
3	,,		Clear	Became infected later
4	,,		Clear	Remained clear
5	,,		Very light infection	Heavy infection later
6	,,		Heavy infection	
7	,,	30 mg. chloramphenicol in alginate subconjunctival injection	Heavy infection	
8	,,			
9	,,	No treatment	Heavy infection	
10	,,			
11	,,	Empty alginate cap	Heavy infection	
12	,,			
13	None	Control to observe effect of applying empty alginate cap	Slight corneal haze	Cleared up in a few days
14	None			

Controls.—In two eyes which were injected with *Ps. pyocyanea* and remained untreated (Nos 9 and 10) a heavy infection resulted, and the same occurred in two infected eyes to which empty calcium alginate caps were applied.

Ocular Effects of Use of Caps

Since the calcium alginate caps were used with a view to their possible clinical application, it was necessary to discover whether the eye tolerated them well or not. (Experiments 13 and 14). Empty calcium alginate caps were applied to two healthy rabbit eyes and the lids were sutured as in the other experiments. When, after 24 hrs, the caps were removed, some discharge and a slight corneal haze were noticed but these cleared up in a few days without leaving any scarring on the cornea. This transitory corneal haze was also noted in the treated eyes which healed. It seems that a very intensive pharmacological effect can be obtained with this form of local application, but that further investigations are needed to find a more suitable substance which the eye will tolerate without irritation.

Summary

A single dose of chloramphenicol powder administered in calcium alginate caps gave protection against experimental *Ps. pyocyanea* infection of rabbit

corneae in two eyes out of six. This result compares unfavourably with the effect of streptomycin (Klein and Millwood, 1953), for a single dose of streptomycin powder in calcium alginate caps or glycerin-gelatine disks gave almost certain protection. This difference may be explained by the fact that streptomycin is bactericidal whereas chloramphenicol is bacteriostatic. The application of non-medicated calcium alginate caps caused a transitory corneal haze in healthy rabbit eyes.

Our thanks are due to Dr. W. W. Walther for permission and facilities to carry out the experiments in the Area Laboratory, Whipps Cross Hospital, London, to Messrs. G. Nissel for the supply of metal moulds, and to Messrs. Albright and Wilson, Oldbury, Birmingham, for the supply of the alginate.

REFERENCES

AZZOLINI, U., and FALDI, S. (1950). *G. ital. Oftal.*, **3**, 211. Abstracted in *Excerpta med., Amst., Sect. XII* (1950), **4**, 653 (No. 2129).
KLEIN, M., and MILLWOOD, E. G. (1953). *British Journal of Ophthalmology*, **37** (in the press).
LANGHAM, M. (1951). *Ibid.*, **35**, 614.
LEOPOLD, I. H. (1951). *Arch. Ophthal., Chicago*, **45**, 44.
——— NICHOLS, A. C., and VOGEL, A. W. (1950). *Ibid.*, **44**, 22.
SORSBY, A. (1951). *Proc. roy. Soc. Med.*, **44**, 737.

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INFLUENCE OF HYPOTENSION ON THE INTRA-CAPSULAR CATARACT OPERATION*

BY

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OF recent years very many changes and advances have been made in ophthalmic surgery, especially in those operations which necessitate opening the eyeball itself in an intra-ocular operation. It used to be axiomatic that the ophthalmic surgeon was allowed one chance and one only; this may not still be strictly true, but it is undeniably of the utmost importance in the precise and meticulously exact technique of the ophthalmologist that everything should go well at the first attempt.

Cataract extraction, one of the commonest major operations on the eye, has undergone as many changes as any, and the rapidly increasing popularity of the intracapsular operation suggests that it is as near the ideal as is at present available. There are undoubtedly more operative risks than in the older extracapsular operation, especially in the hands of relatively inexperienced surgeons or those with limited opportunities for practice, and every step that adds to the margin of safety should be taken. Derangement of the vitreous, or its extrusion from the eye, and haemorrhage from the lips of the incision or occasionally from the iridectomy, with risk of admixture with the vitreous, are two of the outstanding difficulties of the intracapsular operation.

No two surgeons seem to use quite the same technique, nor is there any general agreement upon the best method of reducing intra-ocular pressure; but the fact that some means or other is invariably employed indicates the necessity of it.

General anaesthesia and full doses of curare seem to be favoured in the U.S.A. In Spain moderate doses of curare are relied upon. In Britain the retro-ocular injection of adrenaline and novocaine has been preferred. Curare in safe doses in the conscious patient would seem to be adequate only when reinforced by a rather potent personality in the surgeon.

Retro-ocular injections usually reduce the intra-ocular pressure satisfactorily, but not infrequently the presentation of the lens or of vitreous on opening the globe leaves little doubt of the presence of minor haemorrhages in the cone of muscles; neither immediate pressure on the eyeball following the injection nor Kirby's method of placing the injection only anteriorly in Tenon's capsule serves to prevent them.

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General anaesthesia as ordinarily administered tends to create a slight venous congestion of the eyeballs, and gives rise at times to a troublesome ooze of blood.

These two complications affect still more the surgical treatment of acute glaucoma.

It seems desirable therefore to reduce the intra-ocular pressure almost to atmospheric pressure pre-operatively and to lower the blood pressure to a point where bleeding does not occur.

During the last 3 years various hypotensives have been used experimentally by anaesthetists, mainly to prevent haemorrhage from being a source of embarrassment to plastic surgeons operating on the head and neck, to ophthalmologists in rhinostomy, and to aurists performing fenestration operations. The patients have nearly all been in or below middle age.

I cannot find that any extensive use has been made of these substances in intra-ocular surgery, though Mr. Rycroft has suggested that in glaucoma a fall in intra-ocular pressure might usefully be achieved. Nor is there any record of their use in the upper (cataractous) age groups, where the vessels are hardening and the kidneys becoming less efficient, and where some degree of hyperglycaemia not infrequently exists. Dr. G. P. Goodwin and I have carried out certain investigations into their use in such cases as these from the respective standpoints of the anaesthetist and the ophthalmologist.

For the past 2 or 3 years practically all intra-ocular operations in my clinic have been carried out under general anaesthesia; and for nearly a year the anaesthesia has included the induction of intra-ocular hypotension.

In all cases of intracapsular extraction of cataract the eye was not opened until the ocular tension had dropped below 10 mm. Hg Schiötz.

Results

The results have been most satisfactory; no case of loss or derangement of the vitreous has been experienced, and no haemorrhage from the incision or the iridectomy has proved troublesome, or has even occurred in any extent greater than an ooze of perhaps a minim or so. Recovery in every case was uneventful and rapid and not associated with vomiting.

The drugs used were " Thiopentone " and " Tubarine " and hexamethonium bromide. Other drugs of the methonium group have not been tried by us as they would appear to be less reliable and less certain in their action and to offer no advantages over hexamethonium.

Tubarine and hexamethonium bromide achieve their effect in preventing the acetyl choline from acting on the ganglion cells by the use of an inactive drug (*i.e.*, "block by competition", Paton, 1951). Hexamethonium bromide influences blood pressure by the relief of automatic tone and not by any direct effect on the blood vessels; it has no other depressive effect even in large doses (Paton, and Zaimis, 1951).

Investigation of the ocular fundi of patients under the influence of

anaesthesia and hexamethonium bromide shows that in the retinal arteries the column of blood is greatly diminished though not beaded and the edges are slightly blurred and indistinct. The appearance of the veins is normal and the optic disk is not appreciably blanched. These changes are more marked in the elderly than in the young.

The fall in ocular tension would appear to be solely due to the cessation of the circulation (Duke-Elder, 1952).

In the group of intracapsular extractions, the ocular tension, usually taken on the unoperated eye, was measured with a weightless Schiötz tonometer:

(*i*) before the patient reached the theatre,
(*ii*) when under " Thiopentone "and " Tubarine " but flat,
(*iii*) when tilted into the reverse Trendelenburg position,
(*iv*) when still in the reverse Trendelenburg position but 2 minutes after the injection of hexamethonium bromide.

These findings were correlated with changes in the systolic and, where it could be measured, in the diastolic blood pressure.

Generally it was found that a drop in the systolic blood pressure to about 90 mm. Hg was accompanied by a drop of the intra-ocular pressure to about 11 mg. Hg; this was very satisfactory in the matter of the vitreous but did not stop haemorrhage. Adrenaline locally cannot be used to augment this for the clot then formed does not fit the artery as it expands with the resumation of the normal circulation, and late bleeding may occur.

At a systolic blood pressure of 55 the intra-ocular pressure is in the neighbourhood of 8–9 mm. Hg where the Schiötz tonometer becomes unreliable, and no blood flows from an incision.

In those cases in which it was used, hexamethonium bromide produced a semi-dilatation of the pupil and only a single instillation of the smallest quantity of homatropine and cocaine was required an hour before the operation.

Operative Technique.—The reverse Trendelenburg posture was essential in attaining these low pressures in elderly people, but once the low pressures were achieved the patients could be levelled out for operative purposes and no significant change in the intra-ocular or intravascular pressure occurred for 15 to 20 minutes; if any oozing of blood appeared it was found that a resumption of a few degrees of angle in the position of the patient promptly controlled it, and usually all that was necessary was to tilt the patient's chin slightly downward.

In our series this method of using hypotensives was mainly used in intra-capsular cataract extraction in elderly patients.

The incision was made with a Graefe knife very slightly on the corneal side of the limbus. Three corneo-scleral sutures were then inserted, and the loops laid clear of the incision. A peripheral iridectomy was performed, and the lens removed by Duthie's capsule forceps. Eserine was instilled at this stage, and again before bandaging the eye.

In two instances where the lens capsule ruptured in passing through a rigid pupil in an eye that had previously suffered an iritis and in which an iridotomy had not been performed after releasing the synechiae, no difficulty was experienced in removing the lens by Williamson-Noble's methods of two opposing cystotomes and subsequent drawing out of the capsule.

Three cases of acute glaucoma are not included in the statistics. In two the ocular tension was partly reduced by miotics before the operation and the fall of tension due to hexamethonium bromide was from about 32–35 to 18 mm. Hg.

In one case, following a central retinal vein thrombosis, the intra-ocular pressure dropped from 120 to 35 mm. Hg; had it been proposed to open this eye the change in tension might have been very valuable.

Anaesthetic Technique.—This has been evolved by one of us (G. P. G.) for use in patients of advanced years presenting for intracapsular cataract extraction. In such cases intra-ocular surgery demands absolute control of haemorrhage and a low ocular tension. Derangement of the vitreous or its extrusion from the eye, and haemorrhage from the lips of the incision or occasionally from the iridectomy with its risk of mixing in the vitreous, are two of the outstanding difficulties, and an anaesthetic technique capable of lessening these difficulties is beneficial to patient and surgeon alike.

Premedication is by atropine only, morphia being avoided to eliminate the risk of post-operative vomiting.

Induction of anaesthesia is with intravenous thiopentone. Oral intratracheal intubation is carried out on all cases and if necessary a muscle-relaxant drug such as tubarine is used to assist. Prior to intubation the larynx is well sprayed with a local anaesthetic solution and this local laryngeal toilet undoubtedly assists in maintaining relatively light anaesthesia in the presence of an intratracheal tube.

Maintenance of anaesthesia is assisted by occasional doses of thiopentone delivered through a Gordh needle commonly placed on the dorsum of the foot.

Oxygen is administered throughout the operation and a percentage never less than 50 is delivered with nitrous oxide. It cannot be stressed too strongly that a perfect airway is essential in the aged patient and an intratracheal tube is the only method of ensuring this.

This anaesthetic technique produces quiet respiration with no straining on the intratracheal tube, and has proved very successful with delivery of a high percentage of oxygen.

Pre-operative blood pressure readings are taken as a routine and the figures correlated with those found after the patient has been anaesthetized. There is no doubt that thiopentone, assisted by a muscle-relaxant drug, reduces blood pressure, and we observed that most cases showed a fall in intra-ocular pressure also. We therefore felt that, if blood pressure could be lowered still further, there might be a corresponding improvement in operating conditions.

Burt and Graham (1950) having already stressed the influence of posture on hypotension, we felt justified in cautiously using this method. The average age of our patients was 65 years, the oldest being 83 and the youngest 47 years old. It will be appreciated that these advanced ages bring particular problems to the anaesthetist. Cautious use of the reverse Trendelenburg position to 30° has proved beyond doubt that low blood pressure levels can be reached with a marked fall in ocular tension. So long as adequate oxygenation was maintained there was no cause for anxiety, and in fact the patient usually looked better under anaesthesia than before.

It would appear that the older the patient, the more readily is a state of hypotension, with the accompanying fall in intra-ocular pressure, obtained with posture. So marked has been the reduction of ocular tension that the description of the ' concave ' eye aptly describes the picture.

The following facts have gradually emerged from our results. Postural ischaemia reduces blood pressure and at the same time reduces ocular tension as measured with a weightless Schiötz tonometer. The perfectly slack eye corresponds with a tension less than 10 mm. Hg, which in turn appears to be related to a systolic blood pressure less than 80 mm. Hg. By lowering blood pressure posture also reduces haemorrhage to a minimum, of which there are no visible signs at all in most cases.

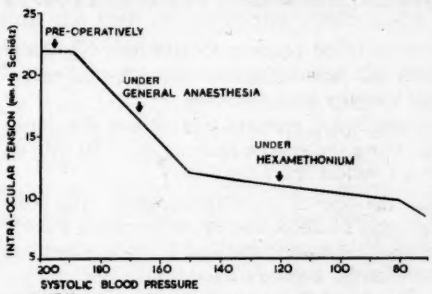

FIGURE.—Average graph of a typical reaction in a healthy woman aged 66.

When the fall in blood pressure is inadequate with posture the hypotensive drugs are used. Hexamethonium bromide has proved most reliable and has been successful in relatively small doses, 10–20 mg. being all that is required in most cases. From experience it appears that only the more robust patients require hypotensive drugs to assist postural ischaemia. The results obtained in an average case are shown in the Figure.

Material

Of the 36 patients who have undergone the intracapsular cataract operation, the average age being 65 years, eighteen were operated upon using postural methods only, and eighteen patients received hexamethonium bromide in addition (see Table, overleaf).

Typical Case Reports

Case 1, female, aged 63 years.—Pre-operative blood pressure 165/100 mm. Hg, ocular tension 25 mm. Hg. Under anaesthesia and posture these figures fell to 110/75 and 12.5; the addition of 10 mg. hexamethonium bromide produced a further systolic blood pressure fall to 60 and an ocular tension of 9.5. The field of operation was perfect with no haemorrhage and a very low intra-ocular pressure.

TABLE
ANALYSIS OF CASES

Age Group (years)	No. of Cases	Treatment	
		Posture alone	Hexamethonium bromide in addition
40–50	2	—	2
51–60	5	1	4
61–70	20	9	11
71–80	7	6	1
80 and over	2	2	0
Total	36	18	18

Case 2, male, aged 66 years.—Pre-operative blood pressure 165/100 mm. Hg, with an intra-ocular pressure of 22 mm. Hg. Posture with the addition of 30 mg. hexamethonium bromide gave a systolic blood pressure of 60 and an intra-ocular of 10, with corresponding benefit to the surgeon.

Case 3, female, aged 65 years.—Pre-operative blood pressure 190/100 mm. Hg, intra-ocular pressure 22 mm. Hg. Under posture and hexamethonium bromide readings of 70 systolic blood pressure and 8 intra-ocular pressure were obtained.

Case 4, female, aged 47 years.—Pre-operative blood pressure 170/110 mm. Hg, intra-ocular pressure 20 mm. Hg. Under posture alone the systolic reading fell to 80 with an intra-ocular pressure of 9, and this produced a perfect operating field.

These cases are taken at random to show the type of result experienced. The post-operative condition of the patient was uniformly excellent and blood pressures quickly returned to normal after normal posture was resumed. The use of hexamethonium bromide in addition caused no prolonged fall as the doses were too small.

Summary

A series of patients presenting for the intracapsular cataract operation were anaesthetized, and the blood and intra-ocular pressures were lowered either by posture alone or with the addition of hexamethonium bromide to facilitate operating conditions.

In the older patients posture alone usually produced the low intra-ocular pressure required. In the younger age groups hexamethonium bromide was required in addition.

Surgical complications during operation were negligible as a result of the low preliminary intra-ocular pressure and the absence of bleeding.

From the beginning to the end of the operation the surgical situation was thoroughly under the surgeon's control.

We acknowledge with gratitude the kind advice of Sir Stewart Duke-Elder and the very valuable work done by Miss Helen Hood of the Kent County Ophthalmic Hospital, Maidstone.

REFERENCES

BURT, C. C., and GRAHAM, A. J. P. (1950). *Brit. med. J.*, **1**, 455.
DUKE-ELDER, S. (1952) Personal communication.
PATON, W. D. M. (1951). *Brit. med. J.*, **1**, 773. *Cited by* Rycroft and Romanes (1951).
——— and ZAIMIS, E. J. (1951). *Brit. J. Pharmacol.*, **6**, 155. *Cited by* Rycroft and Romanes (1951).
RYCROFT, B. W. and ROMANES, G. J. (1951). *British Journal of Ophthalmology*, **35**, 29.

Brit. J. Ophthal. (1952) **36**, 689.

READING TYPES*

BY

FRANK W. LAW

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IN a previous communication (Law, 1951), the desirability of standardizing reading types was stated. The present confused situation was reviewed, and at the instigation of the Faculty of Ophthalmologists, various suggestions designed to clarify it were put forward and comments asked for. As a result suggestions were received from forty sources. These were all carefully studied and collated; they were considered by the Council of the Faculty, and many of them were adopted. The present writer has now been entrusted with the task of preparing a memorandum embodying the Council's final recommendations.

The investigation revealed that the main divergence of opinion arose from the question whether reading charts should be standardized on a strictly scientific basis, or whether they should consist merely of a non-scientific series of pleasing standard graduated types. The first is clearly desirable when an accurate relative assessment is being made for comparative purposes; the second is an obvious everyday need. The Council has accordingly decided to recommend the incorporation of both in a standard test of near vision.

The requirements of the first can be satisfactorily achieved by a photographic reduction of the Snellen type. If this type be reduced to 1/17 of its normal size, the letters in the 6/6 line subtend 5 minutes at a distance which very closely approximates to 35 cm. or 14 in., which is an average reading distance. An example of a Snellen distance chart thus reduced is shown in the Figure. This Figure has been printed from a reduced photographic reproduction. Careful attention will have to be paid to the reproduction to be used for the reading test, for it is obvious that the example given here leaves much to be desired. Reduction from a larger original would probably meet the case.

FIGURE.—Snellen distance chart reduced to 1/17 usual size.

The two main objections to the second are that the deciphering of difficult words is helped by those which precede and follow, and that ascenders and descenders materially assist in the recognition of single words. The first objection may be largely met by ensuring that the selected passages shall not be of too simple a nature, in this sense: while it is not desirable that they should contain many difficult

* Received for publication October 10, 1952.

individual words which the average patient can neither recognize nor understand, they should not be so simple that he is enabled to guess at the word sequence. The second objection may be met by including in all but the largest sizes a few isolated words consisting solely of lower case small letters without ascenders or descenders (*e.g.*, arrow, crane, cocoa, ransom).

It was not thought desirable that reading types should be issued direct from the Faculty offices. Manufacturers should remain responsible for the " lay-out " of their own charts, but it is hoped that the criteria suggested by the Faculty will be generally adopted, and it is suggested that proofs should be submitted to the Faculty for official approval, which may then be recorded upon the finished charts.

The final recommendations of the Faculty are as follows:

(1) " Times Roman " type face shall be used, with " standard " spacing.

(2) Suitable passages of literature shall be selected, and a different passage used for each size of type.

(3) Specimens of printing in sizes 5 pt., 6 pt., 8 pt., 10 pt., 12 pt., 14 pt., 18 pt., 24 pt., 36 pt., and 48 pt., shall be used, starting with the smallest.

(4) A few isolated words consisting only of lower case small letters shall be printed in each size.

(5) Near acuity shall be recorded by the letter N (near) followed by a number indicating type-face size, *e.g.*, N.5., N.8., etc.

(6) The test shall include a facsimile of a Snellen distance chart reduced to 1/17 of its normal size. This shall be used at 35 cm. distance. The result may be conveniently recorded as a " Snellen equivalent ", *e.g.*, N $\equiv$ 6/9.

(7) The test may also include, at the discretion of the tester, reproductions or actual portions of familiar types in everyday use, *e.g.*, telephone directory, railway timetable, newspaper, music, longhand, shorthand, blue-print, etc.

(8) Near Test Types should be produced on sheets about the size of the pages of an average book, *i.e.*, about 9 in. $\times$ 6 in.

(9) The print should be on dead-white matt-surface cartridge paper or cartridge boards, and the latter may be varnished to increase durability.

REFERENCE

LAW, F. W. (1951). *British Journal of Ophthalmology*, **35**, 765.

Brit. J. Ophthal. (1952) 36, 691.

CASE NOTES

RETROLENTAL FIBROPLASIA*

BY

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THE case of retrolental fibroplasia here described was diagnosed during the routine examination of premature babies carried out in Oxford. It is reported because the clinical and histological findings may be of interest to others carrying out similar examinations of premature babies.

Case Report

Clinical History.—A female infant, born October 16, 1951, birth weight 2 lb. 1 oz., first child of second marriage, healthy parents, mother aged 31 years. One sib, born 1944, healthy; a second sib, born 1948, died of pneumonia on third day; miscarriage, 1950.

Pregnancy normal until spontaneous onset of premature labour at 26 weeks resulted in a spontaneous breech delivery. Baby breathed immediately, but it was necessary to keep her in an oxygen tent. Progress was satisfactory and oxygen was stopped at 19 days.

Feeding: expressed breast milk at 48 hrs. Vitamins: A, 14,000 units; C, 30 mg.; D, 3,000 units; all daily from 7 days. Vitamin K, 10 mg. on day of birth. Ferrous sulphate, gr. 3 daily from 8 weeks.

Fundus: routine examination was begun December 3, 1951, and continued at weekly intervals. Natural greyness of the peripheral retina, and pallor of the disk was observed.

14.1.52 (3 months old). Both eyes: periphery greyer, with a few new vessels, temporally.

24.1.52 Left eye, three small areas, apparently exudates, at the edge of the grey area temporally. Right eye, grey areas at periphery increasing.
At this stage the infant was returned to the oxygen tent, with 60 per cent. O_2, until 2.2.52.

28.1.52 Appearances of the central areas of both retinae were within normal limits. Vascular proliferation towards periphery in both. In the left eye the vessels were so finely divided that they gave the appearance of a small haemorrhage, and there were three small exudates at the edge of the grey zone. Vitreous quite clear in both eyes.

1.2.52 Inferior temporal vessels right retina very dilated and tortuous. No detachment or vitreous opacity. Same vessels left retina showed these changes to less degree.

2.2.52 (weight now 5 lb. 7 oz.). Retinal detachment temporally right eye and fine vitreous haze. Treatment with ACTH started, 25 mg. total daily in four doses, each of two injections separated by a 10-minute interval.

4.2.52 Detachment temporally in left eye also.
During the first few days of treatment the detachments seemed to increase, but the vascular engorgement disappeared. Eosinophils fell to zero, and the systolic blood pressure rose to 180 mm. Hg.

6.2.52 Febrile. Little change in condition of fundi.
At this time there was unfortunately an epidemic of gastro-enteritis in the childrens' ward. This child, the smallest and weakest, was one of several severely affected. It was the only one to die.

10.2.52 Frank gastro-enteritis. Treated with penicillin, 250,000 units twice daily, streptomycin 0.05 g. twice daily; continued for seven days. Intravenous glucose saline infusions were also given.

* Received for publication July 23, 1952.

12.2.52 General appearance of right fundus showed little change. Left eye, retinal detachment in temporal quadrant enlarged. The white areas seen earlier coalesced to form a yellowish-white line. Vitreous clear in both.

15.2.52 Right eye no change. Left eye detachment almost flat; little or no dilatation of vessels.

16.2.52 ACTH stopped after 14 days' treatment. Twelve hours after ACTH therapy ended, the child passed blood-stained mucus per rectum, and a few hours later vomited blood-stained material. Twenty-four hours later vomiting increased and the baby collapsed and died.

A *post-mortem* examination was performed approximately 36 hrs after death.

Pathological Findings

Left eye, horizontal section.—There is an area of fibrovascular proliferation at the periphery of the retina on the temporal side, the blood vessels passing from the inner surface of the retina into the vitreous (Fig. 1). The nerve fibre layer anterior to the vascular proliferation is thickened. Changes in the rod and cone layer are due to *post-mortem* autolysis.

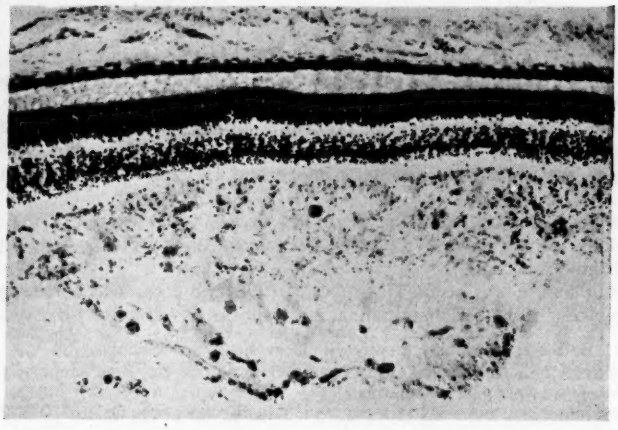

FIG. 1.—Vascular proliferation from inner surface of retina. Thickening of nerve fibre layer. No separation between pigment and rod and cone layer. Haematoxylin and eosin. × 70.

Right eye, horizontal section.—There is an area of thickening and vascular proliferation in the inner anterior part of the retina. This is less marked than in the left eye.

In neither eye is there a retinal separation in the region of the vascular proliferation, nor is there separation of the two layers of the pars ciliaris retinae. There is vacuolation at the equator of the lens, but this and the retinal folding (Fig. 2) in the left eye is regarded as artefact. There is no evidence of congenital deformity in the sections examined.

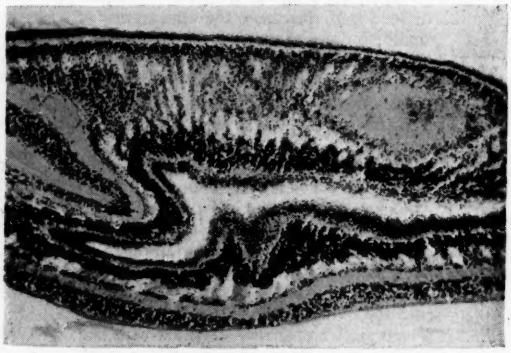

FIG. 2.—Artefact produced by folding of retina. Haematoxylin and eosin. × 70.

Other organs, including the brain, were examined. No changes were found to indicate that the eye lesion was part of a generalized disease. Death was due to enteritis. Sections of lung and kidney were stained with van Gieson, orcein, and periodic acid-Schiff, for examination of the blood vessels. No abnormalities were found. Frozen sections of the suprarenals were stained with Sudan IV, and the small amounts of lipoid remaining were seen to be in the innermost cells of the cortex. Half of the left eye was embedded in gelatin, and frozen sections stained for fat. None was demonstrable in the choroid or retina.

Discussion

The case is reported, first, because, although clinically detachments appeared to be present in the region of the vascular proliferation in both eyes of this child, histological examination did not confirm this. Treatment was not started at the stage of increasing peripheral greyness and tortuosity of the vessels, because we have had the impression that this stage may regress spontaneously. Secondly, there was no clinical or histological evidence of general vascular disease, naevus formation, or cerebral malformation.

We wish to record our thanks to Dr. V. Smallpeice and to the Maternity and Paediatric staff of the Radcliffe Infirmary.

Brit. J. Ophthal. (1952) 36, 694.

APPLIANCES

A NEW ELECTRONIC TONOMETER*

BY

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A tonometer must possess three essential properties:

(*a*) It must be very sensitive in order to give the ocular tension with exact precision. This has not hitherto been achieved by any other mechanical process.

(*b*) It must measure the tension without taking into account the resistance and elasticity of the globe, two factors which vary from eye to eye and constitute an obvious source of error which must be eliminated.

(*c*) It must work in a simple way to make it practicable for clinical use.

With these principles in mind we produced the electronic tonometer which we now present (Fig. 1).

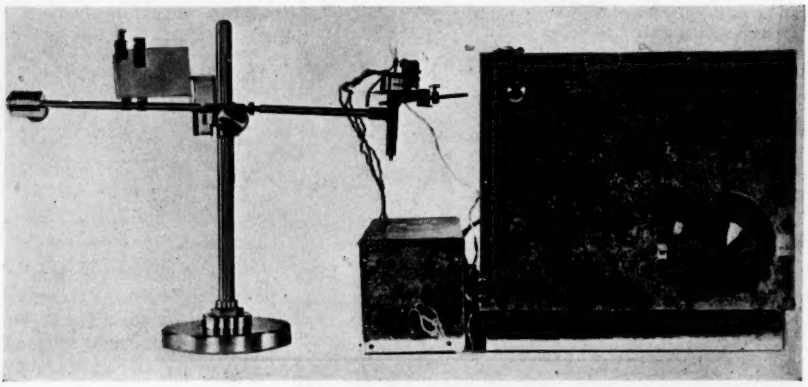

FIG. 1. Electronic tonometer (general view).

Construction of Apparatus

The apparatus (Fig. 2) consists of a small box (1) with an open tube (2) at its base. The tube is 5 cm. long with an opening 8 mm. in diameter. The box is held by a horizontal arm (3), pivoted at its centre (4) to a rack-like device (5), which permits the apparatus to move up and down a vertical column (6).

The box and arm are balanced by a counterweight (7) and fixed in the horizontal position by means of a weak spring (8), which eliminates the danger of contusion or injury to the globe, should the patient move unexpectedly.

Inside the tube (2), but without touching the sides, slides a very light rod (9),

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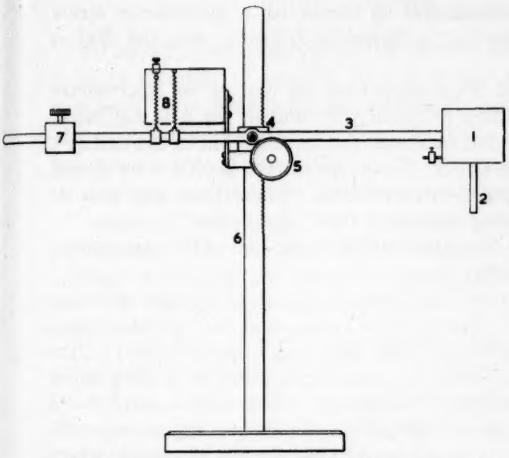

FIG. 2. Diagram of apparatus, showing tube (2) designed to rest upon the cornea, and counterweight (7).

electromagnet 14); if the current to the magnet is cut, the weight (13) falls upon the arm (10), and the end of the rod (9) descends to a new level x_1.

Method of Application

The distance from x_1 to x_0 gives us the exact degree of the ocular tension, and it is possible to measure this distance with the greatest precision by electronic methods. For this purpose we fix to the top of the rod (8) a small steel armature (15). Any movement of this armature will vary the self-induction caused by the magnet (16) on the bobbin (17). For every position of the rod (9)—that is, for every value of x—there is a corresponding value of the self-induction. As this self-induction sets off an oscillating circuit of an oscillating triode, this value corresponds to a frequency F (audible frequency).

We have constructed a second oscillator which includes an identical bobbin, the 3 mm. in diameter (Fig. 3). This rod is supported by a small horizontal arm (10), which is articulated on a pivot (11) and balanced by a counterweight (12). The counterweight must be so adjusted that the rod (9) may be made to rest very lightly upon the cornea, when the surface of the cornea is brought into contact with the end of the tube (2). In this position of rest (0 . . . . 0) the end of the rod (9) is found at a distance x_0 from the line 0 . . . 0.

A weight of 7.5 g. (13) is retained above the arm (10) by a small

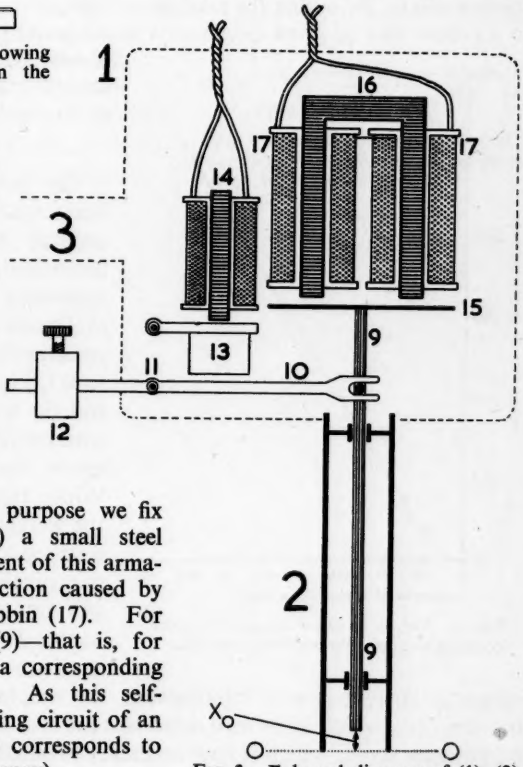

FIG. 3. Enlarged diagram of (1), (2), and (3) in Fig. 2, showing detail of electro-magnet (14), induction coil (16, 17), and rod (9).

armature of which may be displaced at will by means of a micrometer screw fixed to a graduated dial (the screw has a thread of 0.5 mm., and the dial is graduated into 200 divisions).

It is now possible, by a measured displacement on the dial of the micrometer screw, to set this armature in a position identical with that of the first oscillator, thus making the frequency of the second oscillator the same as that of the first (F).

This equality of frequency may be obtained and determined precisely by means of the acoustic beats produced by the two oscillators. These beats can also be shown by means of a visual measuring apparatus (the " magic eye ").

Thus, for each position of the rod (9) an indication on the dial of the micrometer screw enables x to be measured exactly.

As a measure of control the apparatus has been graduated for a series of values x (x_1, x_2, x_3, etc.), varying from -2 mm. to $+2$ mm., and the corresponding graduation for each of these values of x has been determined and indicated on the dial of the micrometer screw. These values of x were determined by placing under the rod small copper disks of different thicknesses (measured exactly by a spherometer). By noting the reading on the micrometer dial which corresponds to a copper disk of given thickness, a linear graph (Fig. 4) was obtained, which shows the measurement of ocular tension exactly corresponding to each given displacement of the rod.

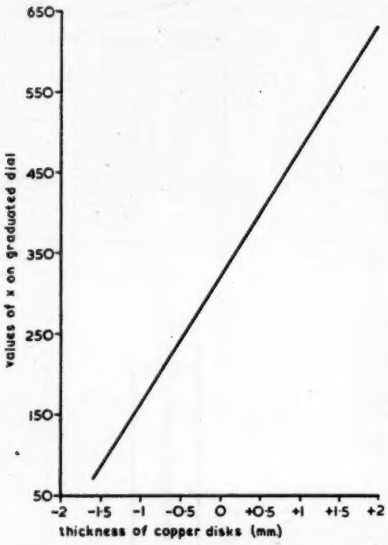

FIG. 4. Graph to show value of x corresponding with displacements of rod (9).

Clinical Procedure

The patient lies flat, with his head horizontal, and gazes in an exactly vertical direction. The cornea is anaesthetized with pantocaine. The apparatus is then lowered down the rack and adjusted by means of the counterweight (7) until the end of the tube (2) is poised above the eye. The rod (9) is adjusted by means of the counterweight (12) until it rests lightly upon the surface of the cornea. While these adjustments are made the weight (13) must be held up by the electromagnet. The position of the micrometer screw which gives the second oscillator the same frequency as that of the first is observed, and the graduation on the dial is noted. The magnetic current is now interrupted; the weight (13) falls and bears upon the arm (10), which in its turn depresses the rod (9). The new position of the micrometer screw, which is now necessary to equalize the frequency of the two oscillators, is observed, and the new graduation on the indicator dial is noted. The difference between the first reading and the second gives the degree of ocular tension.

Results

To standardize and test the apparatus we determined the ocular tension in a large number of people, first with the Schiötz tonometer and then with our own. In these tests, the difference between the two figures indicated by the micrometer screw of the electronic tonometer was found to be in inverse proportion to the number of millimetres of mercury measured by the Schiötz apparatus. The various values followed a linear curve, which increased gradually for the higher tensions (Fig. 5).

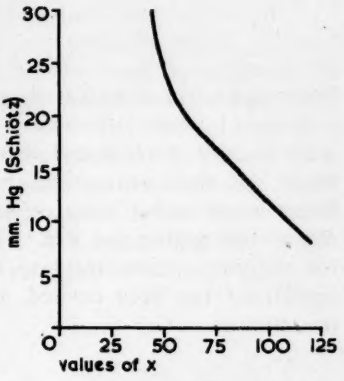

FIG. 5. Graph to show values of x corresponding with measurements obtained by Schiötz tonometer.

It is evident that to standardize our apparatus precisely it would be necessary to use an intra-ocular manometer, and this we propose to do ultimately. A comparison of the figures given by our apparatus with those given by the Schiötz tonometer does in fact introduce an element of inaccuracy, since the Schiötz readings are necessarily influenced by the elasticity and resistance of the globe.

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POST-OPERATIVE EYE MASSAGE IN CASES OF GLAUCOMA*†

BY

T. G. WYNNE PARRY

Bangor

THE importance of regular massage after filtration operations for glaucoma is stressed by most authorities. The difficulty of implementing this advice is great in most cases, since few patients have the touch and understanding to carry out their instructions properly. In elderly patients with arthritic finger joints and a defective sense of touch, etc., to advise massage may mean endangering the eye. To avoid such risks and to make it easy for the most unintelligent to apply regular massage a simple and cheap appliance† has been devised, which has given satisfaction during the last few months.

Construction

The appliance consists of two rubber bulbs connected by a length of tubing. One bulb is of soft rubber capable of easy dilatation; the other is of stouter construction and when this second bulb is squeezed and released, the soft bulb dilates and contracts. The soft bulb is held in a shallow cup of light metal, and a small three-way tap is fixed in the tubing. The illustration will make these details plain.

FIGURE.

Method of Application

To use the apparatus, the soft bulb is held firmly in one hand by means of the shallow metal cup and is placed against the closed eye, and the harder

* Received for publication September 8, 1952.

† It is manufactured by Messrs. Down Bros. and Mayer and Phelps, Ltd., 32–34, New Cavendish St., London, W.1., who have been most helpful.

bulb is then squeezed and released in the other hand with a regular rhythm. In the tests so far made the " massage " (for want of a better term) has been applied with the eyes closed and turned up and then looking right and then left, to avoid pressure on filtering area. It has been found that in most cases the ocular tension is markedly reduced by about twenty to forty inflations; in other cases, the inflations may have to be repeated up to 120 times or more. Many unoperated glaucoma cases also respond well.

Occasionally the softer bulb tends to collapse, probably owing to some leakage of air from the system. To remedy this the small tap is opened to put the closed system in communication with the atmosphere, and the bulb will then immediately fill again.

There has not been much time to carry out extended experiment and tabulation, but the beneficial effect on ocular tension is undoubted. Three of my colleagues have very kindly given the appliance a trial for some weeks and their results are in agreement with mine. It is hoped that this simple appliance may contribute a little towards successful results in filtration operations.

Brit. J. Ophthal. (1952) **36**, 700.

BOOK REVIEWS

Progress in Ophthalmology and Otolaryngology. Vol. I. Edited by M. WIENER, A. E. MAUMENEE, P. E. IRELAND, and J. A. SULLIVAN. 1952. Grune and Stratton, New York. Pp. 160, 59 figs. (15$; £6).

The ophthalmological world owed a considerable debt to Meyer Wiener for summarizing the literature of the specialty during the years war from 1940 to 1946 in two very useful volumes; he has increased this debt by editing, along with A. E. Maumenee, the first volume of what is intended as the first of a series of quadrennial reviews. The main branches of the subject have each been assigned to an author of distinction and the result is half a volume summarizing the main advances in ophthalmology from July, 1946 to the present time. The summaries are short but authoritative and the selected bibliographies are useful. We say " half a volume ", for the second half is devoted to a similar review of progress in the study of the ear, nose, and throat. It is true that in some communities where medicine is still evolving the two specialties may be combined by the same practitioner; but it seems unfortunate that members of more advanced communities practising either specialty should be compelled to acquire a book of twice the necessary size and cost.

Transactions of the International Optical Congress, 1951. Pp. 493. The British Optical Association, London, 1952.

These transactions have been made the subject of individual abstracts which will appear in the March, 1953, issue of *Ophthalmic Literature*.

Journal de Génétique Humaine

THE first journal in the French language to be devoted to Human Genetics has just appeared under the title of "*Journal de Génétique Humaine*". Published quarterly by Editions Médecine et Hygiène, Geneva, Switzerland, it is addressed to all doctors, biologists, anthropologists, and others who may be interested in problems relating to the study of heredity in man. The creation of such a journal was since long overdue, considering the great development and importance to medicine and biology of this branch of science.

The committee of editors is composed of three leading physicians and geneticists, Professor A. Franceschetti (Director of the University Ophthalmological Clinic, Geneva), Professor L. Van Bogaert (Director of the Neuro-Pathological Department of the Institut Bunge, Antwerp), and Maurice Lamy (Professor of Human Genetics of the Medical Faculty, Paris). The committee is also assured of the collaboration of many other scientists from many countries.

Brit. J. Ophthal. (1952), 36, 701.

NOTES

INTERNATIONAL COUNCIL OF OPHTHALMOLOGY

BUSINESS MEETING, JULY, 1952

THE following is a short résumé of the main business conducted by the International Council of Ophthalmology at its meeting at Oxford on July 3 and 4, 1952.

Those present were Duke-Elder (*President*—in the Chair), Berens (*Vice-President*), Hartmann (*Secretary*), Alvaro (*Brazil*), Argañaraz (*Argentine*), Bietti (*Italy*), Law (*Great Britain*), Löhlein (*Germany*), Samuels (*U.S.A.*), Velter (*France*), Bailliart (Committee for the Prevention of Blindness), MacCallan (League against Trachoma). Copper (Secretary for the *Indicia*), Fritz (Secretary for Internationalization), and Dunnington (Vice-President of the International Congress, 1954) were also in attendance.

The deaths of van der Hoeve and Kapuściński were regretfully recorded and the resignations of Tooke and Nakamura received. Charamis (*Greece*), Duggan (*India*), and Stuart Ramsay (*Canada*) were elected in their places.

In the internationalization of visual standards the questions of standardizing optotypes, colour vision, light sense, visual requirements for transport, and tonometry were referred to their respective committees for further study. The study of the requirements of education in ophthalmology in different countries of the world was similarly referred.

The future of the *Indicia* was discussed and it was decided that a more comprehensive volume should be published at each International Congress, containing, in addition to a directory of ophthalmologists, a list of ophthalmological hospitals and journals throughout the world, as well as extracts of the minutes and activities of the International Council. It was suggested that the volume should be sold at each International Congress and that its name should be changed in the interests of linguistic purity to *Index Ophthalmologicus*.

New statutes for the International Federation,* the International Council, and the International Congresses were further studied; these will be presented to the Federation at the International Congress in New York in 1954.

The University of Lausanne is again to present a Gonin Medal at this Congress and it was agreed that the recipient chosen by the Council should first give a lecture at the University of Lausanne before he receives the award at the International Congress.

The Treasurer's report showed that a number of countries were in considerable arrears in their subscriptions to the International Council. It was confirmed that such countries should not participate in the deliberations of the Federation unless their subscriptions were fully paid before 1954.

The "International Dictionary of Ophthalmological Terms" which is being prepared under the authority of the Council will be published in Switzerland by Karger without financial responsibility on the part of the Council.

* It may not be universally known that the International Federation is made up of a delegate from each National Society and meets at each International Congress; the International Council is appointed by the Federation and acts as its executive body.

The following decisions were made regarding the International Congress to be held in 1954. The Congress will take place in the Waldorf-Astoria Hotel, New York City, from September 13–17, 1954. The three administrative languages will be English, French, and Spanish. The two main subjects for discussion will be

(1) Primary Glaucoma—to be opened by Vail of Chicago (general considerations and aetiology), Thiel of Frankfort (medical treatment), and Sourdille of Nantes (surgical treatment);

(2) Aetiology of Uveitis—to be opened by Woods of Baltimore (general considerations), Ashton of London (allergic factors), and Cavara of Rome (role of viruses).

Subscription to the Congress will be, for those living outside the North American continent, full members 15$, associate and scientific associate members 5$; that for those living within the North American continent will be fixed by the American Committee organizing the Congress.

The next meeting of the Council will be held in Paris on June 20, 1953.

E. HARTMANN (*Secretary*)

FACULTY OF OPHTHALMOLOGISTS

STUDY TOURS, 1952

FRANCE

Nantes.—Professor Sourdille did an intracapsular extraction, two iridencleises, and two lamellar and two perforating grafts with consummate skill at his private clinic. Owing to war damage, the hospital services are now carried on in St. Jaques, previously a mental hospital, reconstructed. The wards are divided into small units containing three beds only. There are two theatres where we watched operating by Professor Sourdille and Professor Legrand. It was a joy to see the latter remove an intumescent cataract using a syringe type erisophake. The pathology department contained the latest equipment and there we saw numbers of pathological and experimental sections and sensitivity tests for antibiotics. More operations were seen at the private clinics.

Bordeaux.—Here we visited the Hospital of St. Andrew where Professor Beauvieux and his colleagues showed several cases in the wards and afterwards demonstrated sections of sclerectomies made by the great master, Lagrange. This was a great occasion. Professor Beauvieux showed slides of the lamina cribrosa after injection of the central retinal artery to prove that it is not supplied by this vessel. The importance of the circulation here was stressed in relation to the genesis of cupping. At the Children's Hospital, Professor Pesme operated and showed a large number of cases, retrolental fibroplasia, buphthalmia, retinitis pigmentosa sine pigmento, aniridia, and a suspect toxoplasmosis.

Tours.—Professor Mercier showed us the Eye Department of the State Hospital. A portable applicator for beta-irradiation of the cornea, and the container used for transport of cadaver eyes were objects of interest. Clinical cases included retrolental

fibroplasias, pemphigus, and pseudopterygium treated successfully by corneal graft. Professor Aron conducted us round the Hospital and indicated the ward named after Sir Alexander Fleming. We visited the penicillin factory of Roger Bellon at Mont.

Paris.—We saw Professor Dubois Poulsen do an intracapsular extraction, capsulotomy, and Poulard's operation for entropion at the xv/xx Hospital. Professors Schiff-Wertheimer and Guillomat showed a number of cases. At the Hôtel-Dieu we saw the work of the eye department and the laboratory. The phase-contrast microscope is used for quick tests for sensitivity to antibiotics. We attended a meeting of the Paris Ophthalmological Society, and visited Montfermeil Hospital where we saw cases of successful acrylic lens implants done by Dr. Miller, and a film showing his technique.

Our very warm thanks are due to our French colleagues at all the centres visited, for doing so much to ensure the success of the tour, and for their unbounded hospitality.

Western Germany

Bonn.—Professor H. K. Müller of the University Eye Clinic rendered great service by arranging the details of our visit. The Clinics at Bonn are being rebuilt outside the city and it is intended to construct an eye clinic with 145 beds which will be one of the best-designed in Europe, but at present the old building within the town is still in use. Professor Müller arranged two operating sessions for his visitors in which he showed cataract extraction and corneal grafting. His technique is simple and straightforward. The corneal grafts were obtained from cadaver material and neatly sutured into place. Although the operations were done under local anaesthesia, we were informed that a general anaesthetic was employed for the removal of the sutures. Professor Bücklers, Professor Harms, and *Docent* Dr. Leydhecker read papers upon aspects of their work which was only known in general terms to students of the literature.

Heidelberg.—Professor Engelking and his colleagues received us most graciously and the historical associations of this ancient town with ophthalmology were rightly stressed. Simplicity in the routine testing of colour perception and visual function were among the more important lessons which we carried away from this centre.

Kiel.—Here we met Professor Meesmann, author of the well-known slit-lamp atlas, who arranged two instructive operative sessions.

Marburg.—Here we found Professor Kyrieleis in charge of a newly-constructed clinic, the previous building having been destroyed during the war. The wards were spacious and well laid out, and the out-patient department seemed to be particularly well suited for its purpose. Marburg is unique in having a high school for blind children which takes them educationally beyond matriculation standard, so that many proceed from this school to take full university courses. Professor Strehl, the director, who is himself blind, showed the party round his domain with great verve.

Munster.—Here our host was Professor Rohrschneider, whose interest in trachoma is recognized internationally. Clinical cases of very great interest were shown to us.

It is obvious that in such a brief account of an intensive visit many important matters have to be omitted. We have to record our warmest thanks to our hosts, who went to the greatest trouble to do all in their power to make our visit interesting and enjoyable.

Switzerland

Geneva.—We met Professor Franceschetti at his Clinic for lectures from him on corneal grafting, from Drs Babel, Bourquin, and Kammerman on their research on experimental cataract, heterogeneous corneal grafts, and a perspiration test, and from Professor Linder

on the statistical planning of experiments. Dr. Klein showed us the new Genetics Department, which holds records from the whole of Switzerland.

Professor de Watteville lectured on endocrinology, and operations followed, including a perforating corneal graft. The professor also did a " mushroom " corneal graft, and Drs Bischler, Bamatter, and Dieterlé lectured or demonstrated on scleritis and related conditions, toxoplasmosis (with a striking case), and electro-nystagmography.

Lausanne.—We met Professor Streiff in the operating theatre. Dr. Dufour lectured on the localization of intra-ocular foreign bodies. We visited the Asile des Aveugles, the printing works for the Braille Magazine, and the " Foyer " for the feeble-minded blind. Dr. Rumpf lectured and showed us some of Gonin's original specimens and his beautiful sketches of detachments, and Professor Streiff an instructive series of photographs of his plastic surgery cases. Professor Streiff gave a paper on the measurement of the retinal arterial pressure, and another paper was given by Mr. Cridland. Dr. Dufour presented an excellent series of orbital and cranial *x* rays. We visited Leysin sanatorium for the long-term treatment of known and suspect tuberculosis cases.

Berne.—Professor Goldmann received us at his Clinic, with a lecture and demonstration on gonioscopy; here we had the advantage of gaining practical experience under a born teacher. Next day we enjoyed another of Professor Goldmann's superb lecture-demonstrations, on biomicroscopy of the fundus, and the following morning we saw him operate. The demonstration included diathermy to a peripheral retinal hole which we had ourselves seen stereoscopically. Later Drs Rickenbach and Witmer showed us some of the research work, notably electro-retinography and the analysis by electrophoresis of samples of aqueous. Finally we admired precision ophthalmic instruments at the Haag-Streit factory.

The professional and social entertainment that we received was magnificent and we offer again our warmest thanks to all our Swiss hosts for their most generous hospitality on a memorable and instructive tour.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

Annual Congress, 1953

The Annual Congress of the Ophthalmological Society will be held at the Royal Society of Medicine, 1, Wimpole Street, London, W.1, on April 23-25, 1953.

The Presidential Address will be delivered by Mr. Alex. MacRae on April 23, at 10 a.m. The subject for discussion will be " The Scope of Antibiotics and Chemotherapeutic Agents in Ophthalmology ". The discussion will be opened by Professor Arnold Sorsby, Professor Robert Cruickshank, and Mr. Derek Ainslie.

The Bowman Lecture will be delivered by Professor Sir Geoffrey Jefferson, C.B.E., F.R.S. The afternoon of April 24 will be devoted to the television of operations at Moorfields.

A trade exhibition will be held in the Cowdray Hall. The Annual Dinner, to which members may bring guests, will be held at the Trocadero Restaurant on April 23.

Illuminating Engineering Society

The second of the Trotter-Paterson Memorial Lectures arranged by the Illuminating Engineering Society in memory of two of its distinguished past-presidents, Mr. A. P. Trotter and Sir Clifford Paterson, will be given at the Royal Institution,

Albemarle St., W.1, on January 28, 1953, at 6 p.m. Dr. E. D. Adrian, O.M., P.R.S., Master of Trinity College, Cambridge, will lecture on "The Nervous Reactions of the Retina".

Members of the Ophthalmological Society of the United Kingdom are invited to attend this lecture. Admission will be by ticket only, and these are obtainable from the office of the Illuminating Engineering Society, 32, Victoria Street, London, S.W.1.

TRANSACTIONS

THE society holds a considerable stock of certain volumes of the *Transactions* going back to their first publication in 1881. The Council would be glad to present to members such available volumes as they may desire. No charge will be made beyond the cost of packing and postage. The volumes available are:

Volume	*Date*	*Volume*	*Date*	*Volume*	*Date*
1	1881	9	1889	45 pt. 1	1925
2	1882	10	1890	45 pt. 2	1925
3	1883	11	1891	60	1940
4	1884	12	1892	61	1941
5	1885	13	1893	67	1947
6	1886	23	1903	68	1948
7	1887	33	1913	69	1949
8	1888	35	1915	71	1951

Applications, which will be dealt with in rotation, should be addressed to the Honorary Secretary, Ophthalmological Society of the United Kingdom, 45, Lincoln's Inn Fields, London, W.C.2.

UNIVERSITY OF MINNESOTA

A CONTINUATION course in Ophthalmology for Specialists will be held at the Centre for Continuation Study from January 19 to 24, 1953. Emphasis will be placed throughout the session on the therapy of ocular disorders. Dr. Kenneth C. Swan, Professor and Head, Department of Ophthalmology, University of Oregon Medical School, Portland, will be a visiting member of the faculty. The course will be directed by Dr. Erling W. Hansen, Professor and Director, Division of Ophthalmology, and the faculty will also include members of the staff of the University of Minnesota Medical School and of the Mayo Foundation.

PAN-AMERICAN CONGRESS OF OPHTHALMOLOGY, 1956

THE Pan-American Congress of Ophthalmology will be held in Santiago, Chile, in July, 1956. The Chilean Ophthalmological Society has appointed the following Committee:

President	Dr. Cristóbal Espíldora
Vice-President	Dr. Santiago Barrenechea
Secretary-General ...	Dr. René Contardo
Treasurer	Dr. Abraham Schweitzer.

All matters for publication should be addressed to the Secretary-General, Dr. René Contardo, Huérfanos 930, of 74, Santiago, Chile.

OPHTHALMOLOGICAL SOCIETY OF EGYPT

Fiftieth Anniversary, 1953

The Ophthalmological Society of Egypt will celebrate its Fiftieth Anniversary at the Annual General Meeting to be held in Cairo in February, 1953. The following specialists have promised to assist at this event, with the members of the Society, by lecturing, demonstrating, and performing new operations:

Dr. D. C. Cogan (*Boston, Mass.*).
Prof. Dr. Karl Lindner (*Vienna*).
Mr. T. Keith Lyle (*London*).
Prof. Dr. Louis Paufique (*Lyons*).
Prof. Dr. R. Thiel (*Frankfurt*).
Prof. Dr. P. Thygeson (*California*).

Representatives of all Medical Societies and University Faculties of Medicine, and our colleagues from all over the world are welcome to attend. The subscription fee of £3 E should be paid, not later than December 31, 1952, to the Hon. Treasurer of the society. Further information may be had from the Hon. Secretary, Dr. Mohammad Khalil, 15A Sherif Pasha Street, Cairo, Egypt.

HONOURS

Gullstrand Medal

The Swedish Medical Society has awarded its Gullstrand Medal in gold to Sir Stewart Duke-Elder, who received it at the annual solemn session of the Society in Stockholm on October 7, 1952.

This medal, instituted in honour of Allvar Gullstrand in 1922, is awarded every tenth year to a scientist whose work has effectively contributed to the advancement of Ophthalmology.

The medal was awarded in 1932 to the late Professor Priestley Smith and in 1942 to Professor Alfred Vogt.

James A. Craig Prize

The first award of this prize has been made by the University of Belfast to Sir Stewart Duke-Elder, who delivered a lecture entitled "Primary Glaucoma as a Vascular Disease", at Belfast on October 30, 1952.

Mr. John Foster, M.D., F.R.C.S., has been made an Honorary Member of the Ophthalmological Societies of Australia and New Zealand, and the degree of M.D. (*honoris causa*) has been conferred upon him by the University of Melbourne.

OBITUARY

PROFESSOR ARNOLD LOEWENSTEIN

ARNOLD LOEWENSTEIN was born in 1882 at Carlsbad, at that time a part of the Austro-Hungarian Empire, and he died in Glasgow on October 5, 1952. He was educated in Prague where he graduated M.D. in 1906; as a young student he was drawn to the biological sciences and he received part of his training at the world-famous marine biological station in Naples. His early papers were upon botanical and anatomical subjects, but after qualifying in medicine he was attracted to the study of ophthalmology, and in this he was influenced by an uncle who was a practising ophthalmologist in Prague. He wrote extensively and widely upon many aspects of his chosen specialty, his early papers being written while he was assistant to Professor Fick in the Department of Anatomy in the German University in Prague.

In 1908 he became clinical assistant to Professor Elschnig in Prague and he continued to work there for 30 years. In due course he became a senior assistant *privat-docent*, and he received the title of Professor-Extraordinarius in 1924. By that time he had made over sixty contributions to the literature, including his well-known monograph on tuberculosis of the eye, and he had also collaborated with Professor Kahn of the Department of Physiology in work on electro-retinography, which is still referred to in the literature of electrophysiology.

The many years which he spent upon laboratory work stood him in good stead when circumstances compelled him to seek refuge in Great Britain. He became a whole-time research assistant in the department of Ophthalmology in the University of Glasgow, where he worked in happiness for over 12 years. Shortly after the war he became a British citizen. He continued to devote all his energies to study and research; he was a stimulating and enthusiastic collaborator and many of his British colleagues came to respect his wide grasp of the minutiae of histo-pathology which he delighted to investigate. During the past decade many contributions have appeared in this Journal and in the *Transactions of the Ophthalmological Society of the United Kingdom*. The joint work which he carried out with Ballantyne and Michaelson is amongst his most interesting and important.

Loewenstein was a good European and maintained numerous friendships in many countries as far as circumstances would permit. He had a wide range of correspondents and was an industrious collector of reprints. These were methodically filed and there was seldom a topic raised in general discussion upon which he could not produce some recondite fact or a reference to the literature. He was always willing to take endless trouble, particularly with younger and less experienced workers, to explain his ideas and throw new light upon the subject under review. He loved the countryside and the open air, having been in his younger days a keen mountaineer and skier. He travelled extensively in the country of his adoption and had a surprising knowledge of the Scottish scene. It was truly said, after his death,

> His ability to overcome the misfortunes which befell him was an example and an inspiration to us all. The buoyancy of his spirit and the strength of his will, which

refused to admit defeat, were shining examples of the best qualities to be found in man. He was a kind and true friend, always ready to help with advice and encouragement those who came to him with their problems. His life was spent to the end in the pursuit of knowledge for the benefit of mankind.

READERS of the Journal will regret to learn that Dr. Ida Mann's husband, DR. W. E. GYE, has died in Australia.

BRITISH MEDICAL ASSOCIATION

SCHOLARSHIPS IN AID OF SCIENTIFIC RESEARCH

THE Council of the British Medical Association is prepared to receive applications for Research Scholarships, as follows:

ERNEST HART MEMORIAL SCHOLARSHIP, of the value of £250.

WALTER DIXON SCHOLARSHIP, of the value of £250.

ONE OR MORE RESEARCH SCHOLARSHIPS, each of the value of £200.

These scholarships are given to candidates whom the Science Committee of the Association recommends as qualified to undertake research in any subject (including State Medicine) relating to the causation, prevention or treatment of disease.

Applications are also invited for the following:

INSOLE SCHOLARSHIP, of the value of £250, for research into the causes and cure of venereal diseases.

Each scholarship is tenable for one year, commencing on October 1, 1953. A scholar may be re-appointed for not more than two additional terms. A Scholar is not necessarily required to devote the whole of his or her time to the work of research, but may be a member of H.M. Forces or may hold a junior appointment at a university, medical school, or hospital, provided the duties of such appointment will not, in the opinion of the Science Committee, interfere with his or her work as a Scholar.

Applicants are required to furnish the names of three referees who are competent to speak as to their capacity for the research contemplated.

Applications for Scholarships must be made not later than March 31, 1953, on the prescribed form, a copy of which may be obtained from the Secretary, B.M.A.

A. MACRAE,

Secretary.

BRITISH MEDICAL ASSOCIATION HOUSE,
TAVISTOCK SQUARE, LONDON, W.C.1.

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